THE

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CONTENTS:

	PAGE
Static Induced Current	85
Australian Electrical Notes	88
Electric Light and Gas (*continued*)	89
The Turbines at Niagara	90
Electric Rock Blastings	91
Electric Pumping Plant (*illustrated*)	91
Legal:—National Telephone Company *v.* Graff-Baker (*continued*)	92
C. E. L. Brown's Non-Synchronous Motor for Ordinary Alternating Currents (*illustrated*)	95
Notes	98
Contracts Open and Closed	102
Business Notices, &c.	102
City Notes, &c.:—	
Eastern Telegraph Company	103
St. James's and Pall Mall Electric Lighting Company	104
City and South London Railway Company	105
Newcastle-upon-Tyne Electric Supply Company	105
Traffic Receipts	105
Share List of Electrical Companies	106
The Manufacture of the Volta Incandescence Lamps	107
Locating Trouble on Arc and Power Circuits in Central Station Work	108
Rotation of the Magnetic Field	110
New Patents	110
Abstracts of Published Specifications	111
Correspondence:—	
Effect of a Short Circuit on the Three-Wire System	112
Starting of Multiphase Motors	112
Patent Litigation and Consulting Engineers	112

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UNIVERSAL ELECTRICAL DIRECTORY

For 1893

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STATIC INDUCED CURRENT.

Now that induced currents, and all connected with them, are so much to the front, it may not be unprofitable to give a little attention to a method of obtaining high potential, high frequency currents, which was first introduced in connection with therapeutic work some 12 years ago by Dr. W. J. Morton, of New York City. This gentleman published, in a paper read before the New York Academy of Medicine on March 3rd, 1881, an account of "A New Induction Current in Medical Electricity," wherein was set forth a simple and novel arrangement of statical apparatus resulting in the production of what the author called "Static Induced Current." The apparatus was connected as follows:—To the outer coatings of the condensers of the prime conductors suitable wires and electrodes were attached, forming, together with the patient, a secondary circuit. For the primary, the ordinary discharging rods were just sufficiently separated to enable a steady spark discharge to take place across the air gap between them. The current thus obtained was doubtless of high potential, and its alternations better described as oscillations than as of high frequency. Such a current was hitherto unknown, at least in therapeutics, and its physiological effects appear to have been not far removed from those produced by the Teslaic experiments of more recent times. Its physical effects were not then tested, but we understand that the author has since found that some of the Teslaic effects, such as the glowing of an incandescent lamp when attached to one pole only, were easily produced by its means. In January, 1891, Dr. Morton published an article in the *Medical Record* dealing more fully with the static induced current and its effects upon the human body. Much of this has been reproduced in the last edition of Beard and Rockwell's well-known work upon Medical Electricity, but it contains so much that is interesting upon the physiological effects of such currents, that we think a few lines of this Journal may well be devoted to a consideration of some of the points touched upon. Dr. Morton says in the last-named communication: "If, then, I were to be asked how the Franklinic current" (we presume that by this he means what he has previously described as the static induced current) "differs from the ordinary Faradic coil, I should reply that this one difference of rate of alternation alone placed the two far apart. But it may be urged the current of the induction coil is far greater than that of the influence machine in quantity." This is, of course, true. But at this point in favour of the Franklinic interrupted comes in the element of time. "The motor nerve," says Du Bois Reymond, "is not stimulated by the absolute density of the current density at any given moment, but by the variations from one instant to the other, and the effect produced by these rapid changes increases with their rapidity and their greatness in a given time." "Thus, in the great rapidity of the alternating (oscillating) currents of the spark discharge, particularly in rapid series, as in the Franklinic interrupted,

we find the reason, despite the smallness in quantity, for accomplishing work in producing nerve and muscle stimulation, equal at least to the comparatively slow discharge of the interrupted galvanic or the slowly oscillating induction coil." This form of comparison is no doubt just enough when the ordinary slow vibrating coil is dealt with, and it was only of such coils that Du Bois Reymond had experience when he wrote the words quoted; but in the light of recent discoveries, which may be not inaptly summed in the words Teslaic experiments, we are no longer justified in concluding that the effects on motor nerves and muscles obtained from the static induced current may not be brought about by induction coils when suitable means are adopted to render their alternations sufficiently rapid. With regard to the effects upon the sensory nerves, the ground is less clear. Dr. Morton says that the static induced is not only painless, even when specially directed to motor points, but also produces "a peculiar sensory sensation of lightness and buoyancy." "The arms during the passage of the current feel as if made of cork, and this feeling of lightness persists for some time." The painlessness of the Teslaic currents has been amply established, but we have not heard anything of a sensation of lightness and buoyancy. It may have been there, but, if so, it is curious that one or other of the now numerous investigators who have experimented with Teslaic currents, should not have mentioned it. Be that as it may, the strong similarity between the current obtained by such diverse methods, is only another link in the chain of proof that electrical energy is one and the same thing in whatever way it may be generated, and that when presented under the same conditions, it will perform the same work, either physical or physiological, quite independently of its source of generation. Franklinic and Faradic are terms which, with others, have crept into the vocabulary of electro-therapeutics, to the regret of many who desire that this difficult branch of applied electricity should not be hampered with expressions unknown to, or, at least, unrecognised by, electricians in general. No doubt, such terms are useful to a certain extent, and each branch of electrical science must adopt some special terms to describe phenomena pertaining to the results achieved by the aid of electricity in its own sphere, but these terms, and most of their fellows, refer to the physics of the subject which is, or should be, common to all branches. Dr. Morton will, we feel sure, from his writings and his eminent position as the President of the American Electro-Therapeutical Association, agree with us that Medical Electricity has enough to contend with without the complication of terms and words. It is not hard to see that the static induced current possesses considerable value in certain sections of therapeutical work, and, no doubt, many medical men will be grateful to Dr. Morton as the originator of so simple a method of obtaining high potential, high frequency currents

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Satan Reproving Sin.

DURING the discussion of a paper on "Motive Power" before the American Society of Civil Engineers, some figures were presented showing the relation of cost, working expenses, &c., on the Birmingham Tramways, which, as well known, embrace traction by steam motors, horses, cables, and electricity, the accumulator being used. One, Sears, who had to advocate a system, which appeared to be the special axe which he was grinding, charges the officials of the Birmingham Central Tramways Company with being interested financially in the storage battery which is being used in the Midland Metropolis. This, he loftily remarks, is due to his pretty intimate acquaintance with British commercial methods. This is so like the conceit of the average American, who, because of the failure to make a success of the accumulator by his own countrymen, at once jumps to the conclusion that success elsewhere is due to fraud. We can quite understand that Mr. Sears's commercial methods may be measured by his own bushel, and if electrical appliances in America do not always yield results equal to what are yielded in England, there need be no occasion to look upon this as remarkable. The bad work and slovenly methods which characterise so many American productions are quite sufficient to account for this, and even a want of ability may have something to do with it.

Liquid Air.

THE brilliant series of experiments which Prof. Dewar has been carrying out on the liquefaction of gases, and especially of air, are of more than passing interest to electricians, as a means has now been afforded of examining into the effect of very low temperatures upon the electrical resistance of metals and other substances. Such experiments are being undertaken by Prof. Dewar, in conjunction with Prof. Fleming. It has been found that perfectly pure metals show a power of conducting electricity, which increases as the temperature falls, in such wise that all the curves of temperature resistance would, if produced, pass through the zero of absolute temperature. In other words, if we could imagine a wire of any pure metal stretched through interstellar space, electricity would pass through an infinite length without loss, and without producing any of the thermal effects inseparable from resistance in ordinary conditions. But if there be the smallest impurity, even a slight alloy of some allied metal, this law of diminishing resistance does not hold good. It is suggested that a very sensitive method of testing the purity of metals is thus provided. It is found, for example, that nickel, chemically pure so far as ordinary tests can discover, does not conform to the law, but nickel deposited by Mr. Mond's new process from its combination with carbon monoxide obeys the law perfectly, thus proving that all other nickel, however carefully prepared, retains some traces of impurity.

The Vienna-Buda-Pesth Electric Railway.

NEWS concerning this project crop up from time to time like the stories of the great sea serpent. Mr. Zipernowsky still clings to the idea of running cars between the Austrian and Hungarian capitals at speeds from 125 to 155 miles per hour. He estimates that 800 horse-power will be required for a loaded car weighing about 60 tons. The cars are to be driven by electric motors using 600 ampères at a pressure of 1,000 volts. For the generation and transmission of the electric current it is proposed to establish two large stations, about 37 miles distant from the termini, and to use aerial transmitting lines. Alternating currents transformed up to 10,000 volts are to be used between the main and substations. Even if the capital for this gigantic experiment can be found, which in these days is very unlikely, and concessions are obtained, we fear that 800 H.P. will not propel 60 tons at a speed of 150 miles per hour. The projected line will certainly not pay in competition with the existing railways. The theme serves well as an occasional cheap advertisement.

A Magnetic Detector.

IT sometimes happens that small pieces of magnetisable metal such as needles, tacks, steel and iron chips, &c., take upon themselves to enter the human body unawares and hide themselves in the skin or deeper tissues. As their presence means great inconvenience and sometimes serious injury to the unfortunate individual with whom they take up their abode, it is well that a reliable method of detecting and localising their presence should be forthcoming. An instrument for the purpose has been described in a recent number of the *Electrical Engineer*, of New York. It was devised by Dr. J. B. Williams, and consists essentially of a partially astatic combination of small magnetic needles suspended within a glass tube, the tube being covered with tinfoil to minimise electric action, except for a small space through which the needle can be observed. It is claimed that the instrument is sufficiently delicate to detect the presence of $\frac{1}{8}$th of an inch of steel or iron wire at a distance of 6 inches from itself, and that therefore it is a valuable aid to the surgeon in cases where such substances have, or are supposed to have, entered the body.

Niagara.

OUR readers who are interested in the extensive works which are being carried out with a view to the utilisation of some 100,000 horse-power at this place, will find an interesting account of these works, as well as a number of artistic views of the locality, in a recent number of our American contemporary, *Cassier's Magazine*. The article on the Niagara Falls tunnel deals with the entire scheme in-so-far as it has yet actually been accomplished; and it may be gathered that little more than the civil engineering of the tunnel and the head-race canals has really been carried out. From an independent source we learn that some of the wheel pits are already fitted with turbines; but these relate to the private consumers, and the public supply stations are still enveloped in uncertainty and the battle of the systems. An immense number of schemes have been put forward by the hydraulic and electrical engineering firms in all parts of the world, and several prizes have been awarded. The first prize was divided between two firms of Geneva: Messrs. Faesch & Picard sharing with Messrs. Sautter & Co. It is interesting to note that the turbines proposed by both of these firms were of the "impulse" or Girard type, modified so as to have complete admission, in order that suction pipes might be used. The unit of power for the turbines was 2,500 horse-power. The Pelton Water-wheel Company proposes to use wheels 14½ feet in diameter, coupled in pairs, running at 60 revolutions per minute; each wheel being supplied by five nozzles with hydraulically worked valves. The efficiency of the wheels was guaranteed 80 per cent., though 85 per cent. was anticipated; and the prime cost of the turbines, irrespective of excavation and fittings, was $3·90 per horse-power. We are of opinion that the type of turbine which is best adapted to the Niagara mill site is that one which is capable of running efficiently on a vertical shaft, with water supplied below the engine, and which is designed to work with complete filling and suction pipes. The peculiarity of the mill site which renders this desirable is to be found in the fact that, while the turbines must be placed at the bottom of the fall, the dynamos must be situated at the top.

The Héroult Process of Making Aluminium.

IN an account of the Neuhausen Aluminium Factory by H. Wedding (*Ber. d. Ver. z. Beförd. d. Guverbefl*, 1892, p. 125), we notice a description of Héroult's process as employed by the Aluminium-Industrie-Aktien-Gesellschaft, which may be condensed as follows:—Pure alumina is fused and decomposed by an electric current. The vessel used for the reduction and fusing processes consists of an iron box lined with charcoal, which is connected by copper wires with the negative pole. The lower ends of a number of carbon rods, serving as anode, are placed vertically in the box, the rods being held together by a frame which is connected by a wire to the positive pole. At the commencement of the operation small pieces of copper are placed at the bottom of the vessel, and fused by means of the current. Then alumina is added, which is fused and decomposed by the current. The aluminium is run off as it is produced and cast into moulds. When they make aluminium bronze at the Neuhausen factory, copper and alumina is added at the same time and in the necessary proportions. The working capacity of the factory is 1,000 kilos of pure aluminium in 24 hours.

The Demonstration of Electric Oscillations.

A METHOD of demonstrating the oscillations of Hertz, before a large audience, was successfully used the other day by M. Zehnder. Briefly, this method may be described as follows: The conducting rods were placed in the focal line of a concave mirror; they were then joined up with a common Geissler tube, within which the ends were placed very close together, in order to produce a general luminosity within the tube. A species of relay was employed for increasing the effects. In either side of the terminals of the resonator were two other terminals from a circuit containing 600 small Planté cells, which were so arranged that the current was just able to pass between the terminals. With this apparatus it will at once be manifest that when the resonator responds to the electric oscillations, the discharge from the cells is augmented. By using another Ruhmkorff coil, instead of the secondary battery, a similar result may be produced.

Quick-reading Thermometers.

M. GENGLAIRE has recently devised a quick-reading thermometer for clinical work, of which the basis is thermo-electric. One set of junctions is left exposed, and is for application to the point whose temperature is required, the others enter a small chamber in which a suitable freezing mixture can be placed. At the end of the instrument is placed a specially designed galvanometer, and the whole apparatus is swung in gimbals. The arrangement is very compact, and the designer claims to be able to read to within $\frac{1}{20}$th of a degree Cent.—between 30° and 43°. For observations in which such a degree of accuracy is required, this instrument should be very useful.

Slow Oscillations.

MANY years ago Blaserna and others investigated the comparatively slow oscillations of potential and current that occur on making and breaking circuits containing resistance and inductance. M. Janet has recently communicated to the *Comptes Rendus* some work done in a similar manner with circuits containing capacity as well. With the particular constants of his circuit he found a steady state to be arrived at in about ·004 of a second, and after about two complete oscillations. The question of these oscillations is one of some importance in practical cases, inasmuch as Dr. Fleming's recent work emphasises very strongly the fact known to many that the first few current and potential curves in a transformer (before the forced vibrations are fully in a stable state) may, under certain conditions, result in injuriously high currents and potentials in the transformer. In the case of transformers permanently on the mains (as is very usually the case) no such danger is to be apprehended, but a complete investigation into this and kindred cases of oscillatory currents would be of great interest.

AUSTRALIAN ELECTRICAL NOTES.

[FROM OUR OWN CORRESPONDENT.]

THE Electric Club of New South Wales having completed its first year satisfactorily has made a very fair start on the second. On November 12th a visit was paid to Messrs. Geddes and Co.'s wool store, where the electric light plant has been recently installed by Messrs. Harrisson and Whiffen. Not the least part of the afternoon's entertainment was a trip in the electric launch which forms part of the equipment of the installation. The wool store is situated on the north side of the harbour, and consequently is not easy of access to the wool buyers and other gentlemen who wish to attend the sales, so Messrs. Geddes wisely determined to provide their own means of transit to and from the store, and, having the plant for supplying the necessary charge to the accumulators, naturally took the advice of their engineers, Messrs. Willdridge and Sinclair, when they recommended the purchase of an electric launch. On the afternoon in question, which, unfortunately, was a very wet one, the launch was alongside the steps at Princes' Stairs, Circular Quay, where members and friends, to the number of about 20, boarded her. After going for a short trip up the harbour, at a good speed and showing her splendid capabilities for manœuvring, the launch called at Dawes Point, where the submarine mining corps were at work, and, having picked up the President of the Club, Colonel Cracknell, and two other officers who are members of the Club "electriced," "volted," "motored," or did something of that nature to the store, where the passengers landed and under the guidance of Mr. Sinclair, of Willdridge and Sinclair, and Mr. Brain, of Messrs. Harrisson and Whiffen, wandered over the vast building, examining the electric light installation and engineering generally. The plant, which is of Messrs. Brown & Co.'s manufacture, is not a very large one, nor is it one with many points of special interest, and it must be confessed that the majority of members who accepted the invitation went wholly and solely in order to see and have a trip in the launch, which is the first one which has traversed the waters of Sydney Harbour. The installation consists of about 300 16-C.P. incandescent lamps, and two or three arc lamps, run from a four-pole King, Brown & Co.'s dynamo with a drum armature, giving 160 ampères at 100 volts. The dynamo is coupled direct on the same bed-plate to a compound tandem engine of the vertical type, running at 520 revolutions per minute. The installing and fitting up of the launch has, as I have said, been performed by Messrs. Harrisson and Whiffen, of Sydney. The launch, which is 45 feet long, and has seating capacity for over 40 passengers, is fitted with 72 E.P.S. cells, coupled so as to be used either in series or in two sets of 36 each; the motor is a King-Brown motor, of about 8 horse-power, and is capable of driving the boat at a speed of from 10 to 11 knots at full speed. The launch, which is a very handsome model, and constructed to carry sail, has already created considerable wonder and excitement amongst Sydney boating men, especially once or twice when she has been sailing along dead before a north-easter, in company with some of the crack 24 feet half-deckers, which carry an enormous spread of canvas, and have very little draught, being like dishes more than anything else, and which travel almost as fast as the wind itself. On occasions like these, the *Haidee*, as she is called, has a way of hoisting sail and pretending that she is an innocent sailing craft with none too much speed; two or three half-deckers come sailing after her, picking her up hand over hand, and as soon as they get alongside they may perhaps commence to throw out sarcastic hints as to towing, &c. This is the skipper's opportunity; he reaches forward, and gently, almost imperceptibly, puts on the switch, and very shortly there is a change in the state of affairs, and the crew of the half-decker stare with wonderment and wonder at what has happened, and sail silently home, pondering, the while, as to what sort of a boat that was that they saw, and what relation it bears to the *Flying Dutchman*. The spirit has been taken out of them, and next time they overtake and pass even one of their own class, they are quite silent, and throw out no hints about towing.

On November 25th a club excursion was made, by invitation of Messrs. the Williamson Electrical and Engineering Company, to the central station at Redfern, a description of which I have already sent you. The same night happened to be the night selected for a grand switching on ceremony at the first business establishment which had seen fit to avail itself of the public service, and, as the paper put it, "the irony of fate was well exemplified on this occasion." The Mayor of Redfern, and a host of other gentlemen, numbering amongst them probably many who came with a view of becoming customers if all went satisfactorily, had assembled to perform the ceremony attached to the inauguration of such an enterprise. To quote the paper again, "there were a number of dramatic accessories." A band had taken its place, and the gas was solemnly extinguished to the mournful strains of the "Dead March" as a sort of farewell to the illuminant of other days. The electric lights were then turned on with a great flourish of trumpets, the band this time playing "See the Conquering Hero Comes; the Mayor at the same time, or immediately after, delivering an address explaining how efficient and economical it was and what a splendid light it gave, and how it never went out, &c. The owner of the establishment then followed suit and stated how pleased he was with the whole affair and advising his fellow-traders to follow his example; and just as everyone was telling somebody else what a grand invention the electric light was, out went the light, and nothing would induce it to come on again. Some seemed to think that the failure was due to an excess of modesty, but those who ought to know, said that there was at least one, if not more, short-circuits, and that all the fuses had gone out simultaneously. It must be said, however, in justice to Messrs. Williamson, that as far as the central station was concerned, everything was going as well as could be desired, and the real cause of the accident was that a number of temporary lights had been installed without sufficient provision being made with regard to the wires and fuses. The cream of the whole affair occurred a little later on, however, when the Mayor, being a trifle disturbed about the turn things had taken, thought he would disabuse the minds of any of those whom he thought might be inclined to leave with the impression that the electric light was a failure. "Come up to the Town Hall with me," he exclaimed, in jubilant tones, "we'll show you what electric light is." The invitation was accepted, and a move was made for the Town Hall; the lighting was just commencing to be much admired when once more a main fuse went and once more there was an oppressive silence. There was no attempt at explanation, but everyone suddenly remembered one of those "life and death" engagements, and promptly hurried away to it. It may be mentioned that both these installations have been wired by a local contractor. The street lighting circuits are working well, and since the globes have been off there has naturally been a considerable improvement in the illumination of the area lighted. Two or three days previous to the above-mentioned visit, by kind invitation of Messrs. Williamson, the students of the Electrical Engineering Class at the Sydney Technical College paid a visit to the Redfern central station, under the guidance of Mr. Webb, the lecturer; a large number of students availed themselves of the opportunity of seeing the station, and showed their desire for information by asking innumerable questions both of the lecturer and Mr. Arthur Williamson, who kindly attended with the express purpose, as he himself said, of answering as many questions as the students liked to ask him, a permission of which they fully availed themselves, a very interesting and instructive evening being spent in consequence.

It is with very great regret that I have to announce the death of two prominent members of the electrical circle here—Captain F. C. Rowan, manager of the Australasian branch of the Brush Electrical Engineering Company, and Mr. J. R. Williamson, M.I.E.E., managing director of the Williamson Electrical and Engineering Company, and formerly of the Manchester Edison-Swan Company. Captain Rowan's death was very sudden and entirely unexpected; it is supposed that he got a chill while in the train on his way to Melbourne last week, which developed into acute pneumonia. Poor Williamson, of course, came out here a consumptive, and has never been anything else but an invalid since his arrival; but, at the same time, though he got no better he got no worse, and it came as a shock to all his friends when the fact was known that he had at last succumbed. Almost at the same time as we have lost two of the fraternity, we have gained another in the shape of an

old friend; the *Mariposa* from San Francisco, which arrived on Friday morning last, having on board Mr. J. O. Callender, of the Callender Bitumen Company, who has returned *via* 'Frisco, Vancouver, Montreal and New York, from a six months' trip to the old country. *Apropos* of Mr. Callender's return (he having been one of the founders and mainsprings of the Electric Club of New South Wales), it may be mentioned that the idea has borne fruit so far that a similar club has been instituted in Victoria, the inaugural dinner of which is to take place on Wednesday next.

Sydney, *December 12th*, 1892.

ELECTRIC LIGHT AND GAS.

By Ed. C. DE SEGUNDO, Assoc. M.Inst.C.E.

(*Continued from page* 35.)

In the first part of the last article I attempted to show that incandescent domestic electric lighting under public supply, from central generating centres, could not compete light for light with gas lighting when compared on the basis of money cost alone, because under existing conditions in practical everyday work, the electric light at supply companies' prices and pressure is, roughly, about double the price of gas, light for light; and because if we begin to argue about the lamps that will be made when the Edison-Swan patents expire, and about the strides that electric light will make in the future, we are at once confronted with possibilities for gas which show that on the basis of money cost light for light, gas can with ease hold its own against the greatest advances that electricity is likely to make until the short cut from heat to electricity energy on a practical scale is discovered.

But the reason for the growing demand for the electric light is to be sought elsewhere than in money economy. There are numerous directions in which electric light and gas are quite incomparable; that is to say, where electric light or gas light, as the case may be, is absolutely necessary.

It has been indisputably proved that the electric light, owing to its nature, is powerless to pierce a fog so effectively as gas or oil, hence the electric light is not suitable for lighthouses. On the other hand gas destroys the quality of some of the pigments used by artists, hence gas lighting is unsuitable for picture galleries. The main point of difference between gas and electricity as illuminants is that the production of the electric light is not accompanied by any combustion at the point where the light is produced, nor are any noxious vapours given off, nor is any heat evolved to any sensible extent. Now, however much gas may be improved, it is quite impossible for gas lighting ever to possess this characteristic.

There are naturally occasions when this characteristic is indispensable, and on the other hand under certain circumstances, it is of no consequence whatsoever. In the first case electric light would hold its own over gas were it three times the price, in the second case electricity would not be thought of.

Another point of difference in which gas cannot possibly compete, is the manner in which the electric light can be turned on and off, and which admits of the switch being placed at any convenient point. This is denied to gas. It is obvious that a great economy in the hours of consumption can be effected by turning the light off when not required, but as this entails the relighting of gas by means of a match or a taper when the light is again required, great waste is incurred by leaving the gas burning although not required.

There can be little doubt that for domestic lighting electricity possesses so many peculiar advantages over gas that everyone who can afford to spend a little extra money on home comforts, would not hesitate to use the electric light were it not for the heavy initial cost of installing the wires. But as a matter of fact no new building is now considered complete unless wired for the electric light, except, of course, such buildings as are intended for those who of necessity have to practice rigid economy. Before leaving the question of economy in money of gas and electricity, light for light, it would be not uninteresting to inquire whether it is possible to make electricity on the premises, to be lighted more economically than it could be drawn from the supply mains, or than gas burnt in ordinary burners to produce an equivalent amount of light.

It will be necessary to assume some set of conditions from which to argue. To simplify matters, we will take in the first instance the case of a warehouse, or a suite of offices, or any such building in which light is required during some fixed portion of the day, and where it is not necessary to use accumulators. We will then be able to compare roughly the cost of illumination, light for light, as obtained:—

(1.) From the public supply mains at 7d. per unit.

(2.) From a dynamo, driven by a gas engine, using 30 cubic feet of ordinary town gas per B.H.P. hour.

(3.) From gas burnt in ordinary burners yielding $2\frac{1}{2}$ candles per cubic foot.

Assume the amount of illumination required to be 800 candle-power distributed over 50 burners giving 16 candle-power each.

Assume that the lights are burnt in each case, on the average, 3 hours per day each, or roughly 1,000 hours per annum.

Take 5 per cent. for interest on capital outlay for gas engine and dynamo; 5 per cent. depreciation, and £10 per annum for oil, waste, petty disbursements, and occasional attendance.

Assume that an incandescent lamp of 16 candle-power consumes electric energy at the rate of 4 watts per candle.

We should then have

(1.) $$\left\{\begin{array}{l} 50 \text{ lamps} \times \dfrac{64 \text{ watts} \times 1{,}000 \text{ hours}}{1{,}000 \text{ watt-hours}} \times 7\text{d.} + 360\text{d.} \\ \text{rent of meter, main switch, fuse, \&c.} = 22{,}760\text{d.} \\ \text{per annum.} \end{array}\right.$$

(2.) $$\left\{\begin{array}{l} 50 \text{ lamps} \times \dfrac{64 \text{ watts} \times 1{,}000 \text{ hours}}{1{,}000 \text{ watt-hours}} \times \left\{\begin{array}{l}(30 \text{ cubic} \\ \text{feet per B.H.P. hour)}\end{array}\right. \times \dfrac{1{,}000 \text{ watts}}{746 \text{ watts}} \times 1{\cdot}18 \ (= \\ \text{counter efficiency of dynamo)} \left\{\dfrac{3\text{s. per } 1{,}000 \text{ cubic ft.}}{1{,}000}\right. \\ + 4{,}800\text{d. } (5\% \text{ interest}) + 4{,}420\text{d. } (5\% \text{ depreciation}) + 2{,}400\text{d. (oil, waste, \&c.)} + 120\text{d. } (= \text{rent} \\ \text{of meter}) = 17{,}180\text{d. per annum.} \end{array}\right.$$

(3.) $$\left\{\begin{array}{l} \left\{\begin{array}{l} 50 \text{ lamps} \times \dfrac{16 \text{ candles}}{2\frac{1}{2} \text{ candles}} \times 1{,}000 \text{ hours} \end{array}\right\} \left\{\dfrac{3\text{s.}}{1{,}000}\right. \\ + 10\text{s. rent of meter} = 11{,}640\text{d. per annum.} \end{array}\right.$$

From the foregoing calculations it would appear that the electric supply alone, irrespective of incidental expenses such as lamp renewals, would cost, roughly, twice as much as gas for a light equal to 800 candles, and that a gas engine driving a dynamo direct would entail an annual outlay about half way between the former two.

Of course, the expense under conditions (2) would be enhanced by the use of accumulators which are indispensable in all domestic installations, and would be diminished were the amount of light produced to be greatly increased, or were arc lamps permissible instead of incandescents to produce the 800 candle-power.

Let us consider a small private installation such as would be required for the average house rated at, say, £80 per annum in any but the ultra fashionable districts in London.

About 30 8-C.P. lamps would be required all over the house. It may be assumed that these would burn on the average 1,000 hours per annum, and that not more than 15 lights would ever be in use simultaneously.

We may assume that a one horse nominal gas engine would be used, charging 16 accumulator cells, the lamps being run on a 30-volt circuit.

We may take the mechanical efficiency of the engine at 70 per cent., the efficiency of the dynamo at 75 per cent., and the efficiency of the cells at 70 per cent. (under the conditions of use by unskilled attendants in domestic installations.) We must write off 5 per cent. interest on first cost, 15 per cent. depreciation (including cells), and £6 for oil, waste, and sundry petty expenses.

The gas used would be roughly as follows:—

Allowing 22 cubic feet per I.H.P., we should arrive at

$22 \times \frac{1,000}{746} \times \frac{1}{70\%} \times \frac{1}{75\%} \times \frac{1}{70\%} = 80$ cubic feet per kilowatt at the lamp circuit terminals of the accumulator. But a certain amount of gas should be added to this, corresponding to unnecessary overcharging, occasional extra charging to bring the cells up, and so forth. The author's experience with such installations as these leads him to add 15 per cent. on to this, on $80 + \frac{15 \times 80}{100} = 92$ cubic feet.

Following our methods of calculation we have

(1.) 30 lamps $\times \frac{32 \text{ watts} \times 1,000 \text{ hours}}{1,000 \text{ watt-hours}} \times 7\text{d.} +$ 180d. rent of meter, &c., = 6,900 pence per annum.

(2.) 30 lamps $\times \frac{32 \text{ watts} \times 1,000 \text{ hours}}{1,000 \text{ watt-hours}} \times \frac{92 + 3\text{s.}}{1,000}$ + 2,800d. (interest), + 7,200d. (depreciation), + 1,440d. (oil, waste, &c.), + 72d. (rent of meter), = 14,691d. per annum.

(3.) 30 lamps × 8 candles = 240 candles at $2\frac{1}{2}$ candles per cubic foot = 96 cubic feet × 1,000 hours $\times \frac{3\text{s.}}{1,000}$ + 72d., rent of meter, = 3,528d. per annum.

The results are somewhat different. Gas burnt direct is still *facile princeps*, the supply company comes next about double as much, while the private installation is now four times greater than gas.

From the foregoing examples it will be evident that while electric energy costs 7d. per unit, and while incandescent lamps require four watts per candle, electric light is roughly double the price of gas light for light, and that there is a limit to the size of the installation in which a gas engine is more economical than the electric supply from the mains of a company.

(To be continued.)

THE TURBINES AT NIAGARA.

THE *Railroad Gazette*, of New York, presents illustrations of the turbines at the Niagara utilisation works, which are being constructed by J. P. Morris & Co., of Philadelphia, to the designs of Faesch and Piccard, of Geneva. We have already described the general features of the Niagara scheme, and need not further enter into them. In each wheel pit, as then described, there are to be two turbines placed 40 feet apart, and each turbine is itself a double wheel consisting of two turbines of the Fourneyron or outward flow type, fixed 10 feet 10 inches apart upon a vertical shaft. Each wheel has a diameter of 5 feet 3 inches at the receiving circumference, and the speed of revolution is 250 per minute, the water consumption being 430 cubic feet per second. As customary with the Fourneyron wheel, there are three sets of buckets, the divisional rings between each set being about 1 inch thick, and the total height of the three tiers being about 10 inches, exclusive of the divisional rings. The speed of the receiving circumference is thus that due to a height equal to half the available fall. The two turbines are placed at the above distance apart of 10 feet 10 inches at the upper and lower ends of the guide-blade chamber, into which water is admitted laterally by a large steel plate pipe which descends from the surface and curves into the guide chamber. This pipe has a diameter of $7\frac{1}{2}$ feet, and provides, therefore, for a velocity of flow of only $9\frac{3}{4}$ feet per second. There are, as usual in Fourneyron wheels, 36 guide blades. This was Fourneyron's own number for both guides and buckets in wheels of any size, though we never heard any satisfactory reason for this number, but in the present case the wheel vanes are 32 in number only, probably because of the flatter inclination of the vanes, causing them to occupy more space in the wheel than do the more sharply inclined blades in the guide chamber, and there is no variation in the depth of the wheel from its inner to its outer circumference, but equal area in the passages is secured by the customary method of adding to the thickness of the blades, when cast, sufficient to allow for this correction. The breadth of the ring of buckets, measured radially, is only 6 inches, and there is not that large difference between the inner and outer diameters which is often made, without any very good reason. In the guides there are the same divisions into three tiers as in the wheels, and the flow of water to them is facilitated by the form of the guide chamber floor. Into the middle of the guide chamber water is admitted by the pipe of $7\frac{1}{2}$ feet diameter, and water flows up and down to the wheels, the base of the pipe carrying, of course, the load of water in it, and the floor of the guide chamber keeping the pressure of water off the foundation plate of the lower turbine; but the upper boundary of the chamber is perforated, and admits pressure upon the disc of the upper turbine, and thereby is sustained the whole of the weight of both turbines and their shafts, fly-wheel, and the revolving armature of the dynamo, which is fixed upon the top of the shaft. As this shaft is of a total length of 135 feet, it was necessary to keep it as light as possible, for which purpose it is chiefly composed of lengths of steel tube 38 inches diameter. The shaft is thus proportional; the lower turbine seat is about 8 inches diameter, the steady bearing within the central tube of the guide chamber is $8\frac{3}{4}$ inches, and the upper part is 10 inches where it passes through the steady bearing. Thence, to a height of 30 feet $9\frac{1}{2}$ inches above the centre of the guide chamber, the shaft is of hollow plate steel in two lengths of 38 inches and $48\frac{3}{4}$ inches diameter respectively, the larger part carrying a 14 feet 5 inches forged fly-wheel of 10 tons weight. Here is a solid length of 11-inch shaft with a steady bearing, followed by two lengths of 38-inch tubes, another 11-inch steady bearing, and finally two more lengths of 38-inch tubes complete to the top steady bearing, above which comes the armature. The guide chamber is strongly supported on a pair of riveted girders 5 feet in depth, laid across the wheel pit, which is 20 feet wide, and the pit bottom is sunk fully 30 feet below the lower turbine.

Regulation is effected by means of a cylindrical sluice, or slide, closely fitting over the outside of each turbine, and capable of being raised so as to shut off the discharge of each. By this external sluice, the enormous reduction of efficiency which occurs in pressure turbines when any set of buckets is run partially full, as happens when a similar sluice is interposed between the wheel and the guide blade, is avoided, for the outside sluice, though causing friction, maintains the passages full of water. The triple division of the wheels into three tiers confines any loss of efficiency due to the action of the sluice to one-third of the wheel. In the present arrangement of two wheels, only one-sixth of the power need be affected by sluice action, were it not for the complication of working each sluice independently, as would then be required. These sluices are automatically regulated from the dynamo floor by a governor, said to be new, and claimed to maintain the speed within 3 per cent. of normal under a load variation of 25 per cent.

The drawings to which we refer show the guide blade angle to be about 22°, that of the buckets about 18°, while the narrowest measurement between the buckets is $1\frac{1}{4}$ inches. The wheels are said to be of bronze, but are shown of cast-iron. They revolve in plan view with the hands for a watch.

The placing of the two wheels as arranged is a very convenient arrangement, the only objection to which is the sacrifice of some 10 feet of the available fall at the upper wheel, a loss probably faced more cheerfully in view of the enormous supply of water available, but there is nothing to which exception can be taken in the general arrangement, whilst the detail design of the turbines themselves is good and the strength of the shaft sufficient, and the sluice is probably the best that could have been applied to the outward flow variety of turbine, of which it might be added that for large powers it seems to be very much more suitable than for small powers, and also to be very suitable at Niagara for the constant level of water which may be expected there, a varying tail race being, perhaps, worse for this type of wheel than for any other. At Niagara are absent the chief items which lead many engineers to object to the Fourneyron turbine, and, as we have before intimated, the success of a European design is the more marked in a land of such large water-powers as America, where the greater number of turbines made are of that double type

which provides for a large water consumption in a very small space, but are not, we think, altogether capable of working with the efficiency claimed for them. They are cheap, and, no doubt, eminently serviceable for a country of large water-powers.

ELECTRIC ROCK BLASTINGS.

UNDER the above heading, Mr. W. L. Saunders recently described before the American Society of Civil Engineers, the system of rock blasting now prevalent in America.

In this paper the author refers briefly to the system of electric firing by static electricity generated by frictional, or by voltaic means, and condemns it as unsatisfactory, owing to the small heating capacity and the great danger of mis-fires from short-circuiting. In the best system the current is generated by a small dynamo and firing is effected by actual incandescence of a wire submerged in the explosive. The current produced by the dynamo is at first short-circuited in the machine, and when the point of greatest intensity is reached it is sent into the exploder circuit. The electric exploder consists of a small cartridge tube, about an inch in length, into the open end of which two wires are cemented with sulphur; the two wires are connected by a bridge of fine platinum wire which is buried in the fulminate of mercury, which fills about $\frac{3}{4}$-inch of the small case. The leading wires are of pure copper of No. 20 gauge well insulated.

If several exploders are placed in series in one charged hole they will explode practically instantaneously and fire the whole charge with much better effect than where a single exploder only is used. Suddenness of explosion is more important than mere volume of gas liberated.

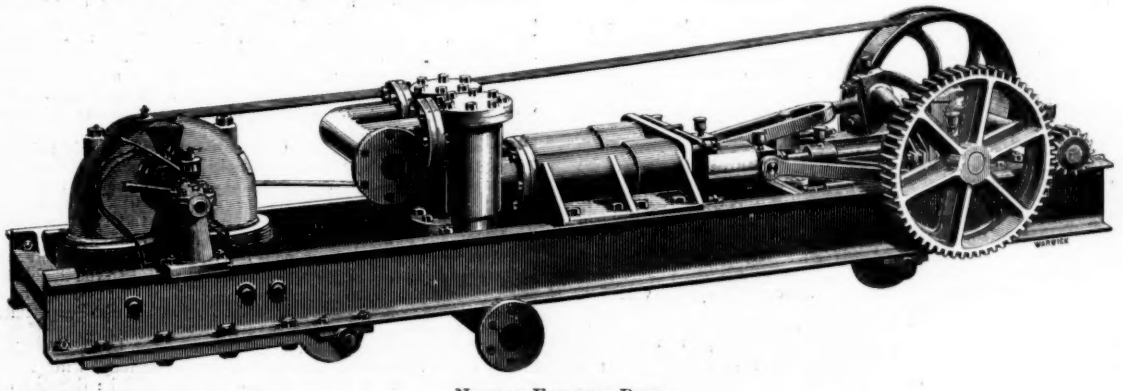
The bridge of platinum wire whose incandescence is the cause of explosion requires to be of exact length and diameter in all exploders to ensure simultaneity of action, and a uniform quality of solder should be used in fixing the bridge to the leads, or this object may be defeated. Then the current used must be strong enough to make the bridge red hot, and, indeed, there is no disadvantage in having a strength sufficient to burn the bridge. One of the batteries or hand dynamos employed is known as the plunge battery. It is simply a small dynamo in which the armature is revolved by means of a handle pressing a rack which drives a pinion on the armature spindle exactly as in the old Otto and Langen gas engine. When the full stroke of the rack has been made, its end presses a spring piece, breaks the contact, which short-circuits the current through the machine and discharges it through the exploder leads or outside circuit. The machine is operated by a single full stroke of the rack, the movement being most rapid at the end of the stroke. A somewhat similar machine is made with a pull rod or tape, but the best and most recent contains a spring, which is pressed up to a certain tension by the operator and liberated by a trigger when it turns a quadrant rack, and this drives the armature. By this means the current generated is always identical, and uniform results are obtained, without any skill or experience in the operator, whose sole duty is to press a handle slowly as far as he can until the tripping point is reached, when the battery will discharge the same current at each operation. The spring can be adjusted by a nut to varying tensions to suit the number of exploders in the circuit.

Though under special circumstances the current of the electric light may advantageously be employed for shot firing, it is not usually safe to so employ it in ordinary works, owing to the risks involved, but Mr. Saunders has known of a case where the electric light current was and is used with satisfaction and safety; but in the blast circuit there is a safety plug which is kept in the superintendent's office, and until this is inserted the turning of the switch will not make the circuit. To the use of an incandescent wire heated by a current of small potential and large ampèrage, Mr. Saunders attributes the almost entire abolition of the fuse in important rock blasting operations, a result he appears to think would never have followed the system of ignition by a sparking current of small volume and high intensity.

We think, however, that Mr. Saunders rather exaggerates the superiority of American practice in rock blasting, and has not as full knowledge as he might have of European practice, but we have frequently noticed that Americans describe as *the* American system any method of carrying out work which has shown itself best suited to American requirements. Being used by Americans evidently naturalises it, just as we know a man who picks up cheap oil paintings for a few shillings apiece which become invested with immense value at once. All the man's dogs have long pedigrees as soon as they become his.

ELECTRIC PUMPING PLANT.

MESSRS. ERNEST SCOTT & MOUNTAIN, LIMITED, electrical and general engineers, Close Works, Newcastle-on-Tyne, have recently completed for the Newton Colliery, Northumberland, an electric pumping plant which suits the special requirements of colliery pumping, and especially where it is necessary to move the pump about. The plant consists of steam engine and generator and horizontal pumps and meter. A vertical engine of 10 H.P. is fixed at bank and drives on to a Tyne compound-wound dynamo, constructed to give an out-put of 30 ampères at an E.M.F. of 200 volts, when running at a speed of 1,100 revolutions per minute.



NEWTON ELECTRIC PUMP.

The type of dynamo used is of Messrs. Scott & Mountain's well known two-pole type. The current from the dynamo is taken to a switchboard fitted with quick-break double-pole switches mounted on an enamelled slate base, and a voltmeter and ampèremeter are also provided for measuring the current and pressure.

The current from the switchboard is taken down the shaft by a pair of 7/15 vulcanised cables. The pumps are of the two-throw type, the rams being 6 inches diameter by 10 inches stroke. It will be noted from the illustration that the pumps are mounted upon two channel iron girders which are firmly bolted to distance pieces, the centre distance piece carrying the guides for the tail rods. The crank shaft and countershaft are mounted at one end of the girders and upon the crank shaft is keyed a spur wheel driven by a pinion on the crank shaft. The motor is placed behind the pumps and

whilst for the purpose of illustration it is not shown covered, a strong brass cover was fitted entirely over the motor to prevent dust and dirt getting to the working parts.

The power from the motor was transmitted to the pumps by an endless cotton belt specially made to resist the wet, and it will be noted that it drives on to a pulley placed on the end of the crank shaft.

The pumps are mounted on wheels enabling them to run along the tram rails in the pit.

These pumps have been at work for some time, and not only are they delivering more than the guaranteed quantity of water, but are also giving the colliery officials every satisfaction.

LEGAL.

NATIONAL TELEPHONE COMPANY *v.* GRAFF-BAKER.

High Court of Justice.—Chancery Division.

(Before Mr. Justice Kekewich.)

(*Continued from page* 69.)

FOURTH DAY (*continued*).—JANUARY 12th, 1893.

Mr. JAMES SWINBURNE, re-examined by Mr. BOUSFIELD, said: There was a difference in the character of the noise on the Friday and Saturday, and I should also mention, although I do not know the reason for it, that the telephone-speaking itself, both on Friday and Saturday, seemed much smaller in sound—that is to say, the voice sounded much softer. I do not know why it should be, but it struck me so, except when one particular transmitter was used. One time an operator used what is known as the Hunnings transmitter, when the sound at our end was so loud that though Mr. Macrory had a telephone at his ear, and several of the other observers had telephones at their ears, I, who had no receiver at all, could hear what was said on their telephones; but otherwise the speaking seemed much softer.

Did you notice the state of the rails on Friday and Saturday as regards the snow?—It had been snowing. There had been people out cleaning the rails; it was, practically, a fight between the people who were cleaning the rails and the snow coming down. The effect of the snow upon the contacts would be to make them bad; that is to say, to cause a variation of the current due to that condition; it would disturb the telephones. Those variations would not exist to anything like the same extent when there was no snow.

When you have a system of single overhead conductors of one polarity, is there any necessity to guard against sparking at any point between your conductors?—There is none whatever.

How does that compare with the case of crossings when you have double conductors to provide for?—It makes the difference that you have, as I put it, a difference in kind. As soon as you use the double conductors you have another set of difficulties, arising from having to deal overhead with two sets of conductors which you frequently have to bring into close proximity. You get the difficulties due to sparking across, arcing across, by anything touching the two lines, or by the trolley leaving the one line and touching the other. You get, therefore, a difference in kind as well as a difference in degree, due to the necessity of doubling the trolleys.

Does that observation also apply to the conduit system with two conductors in it?—Certainly.

Assuming that the Blackpool system is only a single conductor in a conduit, does that, in your view, give much light as to the practicability of a system with two conductors in a conduit?—No, it is not the same thing; it is easier to work. As regards the Blackpool system, I have been informed, I think, that there is a single wire inside, and that the return is by the rails.

Would the Blackpool system affect telephones by the roadside?—It would have, roughly, almost as much effect as the overhead system of telephones, and it has the advantage of bringing only one conductor down through the plough instead of two.

Assuming in Blackpool the telephone system was to be put up and connected with water pipes running near the rails in the streets, what would be the effect of the Blackpool system on that?—I think you would have the same sort of effect as you have in Leeds.

So far as the Buda Pesth system has been brought to your notice, does it affect your view that that system for Leeds with the incidents which have been pointed out is not a practicable one?—There has been nothing to make me alter my opinion on that point.

My learned friend asked you whether you superintended the Elieson tramway, and you said you had not?—Not personally. I was electrician to Messrs. Crompton, who had to do with it, but I was generally at the works. I have designed some of the motors. It was a secondary battery system. There was a car by itself, so as to form an electromotor, and that drew either one or two cars. The system had a very chequered existence for two years. The working was ultimately a failure.

Mr. MOULTON: Was it a failure of working?—I had to repair a number of the motors; I should say it was a failure of the working.

Mr. BOUSFIELD: I do not know whether you can tell us any of the difficulties which arose as to secondary batteries?—They were heavy, and they were not very good. They used to run short of charge when the cars were out.

As a matter of opinion, what effect, in your view, would the constant shaking of the car have on the secondary battery?—The effect of the constant stoppage on accumulators is one of the greatest difficulties that arises in accumulator traction. The accumulator is made of lead plates with a coating of oxide, and the great difficulty in making batteries is in making that oxide adhere to the plates properly. It is difficult enough to make them adhere when your plates are still, but when you are jolting the plates about all day, the coating of oxide falls out, and the plates get spoiled. The difficulty of the power of the battery running out is very serious, because you not only have to drag home the car, but you have to drag home a heavy car full of batteries. The battery car itself is of great weight, and you have to tow that home as well as the ordinary cars, so that, apart from breaking up the traffic, and causing stoppage on your lines, it is a very serious matter. There was one point which arose in my cross-examination, as to which I am not sure that my answer conveyed the meaning that it ought. That was the question of the snow also going on when the tramways were stopped. I do not know whether it was meant to be suggested to your Lordship that that was a reason for the disturbance going on when the tramway was stopped, but the snow going on when the tramways were stopped would have no effect on the telephone, because there was no tramway current to disturb them.

Mr. MOULTON: There was a lawsuit about the Elieson tram, was there not?—Yes.

Was it not proved there that on one occasion on which it was stopped was because they had forgotten to charge the batteries before they sent them out?—I do not know, because I was not in that lawsuit.

Are you prepared to say that Mr. Crompton did not take a contract to work those batteries?—He may have, but I do not know the terms of the contract.

Mr. BRUNO ABDANK ABAKANOWICZ, consulting engineer, of St. Maur, near Paris, Knight of the Legion of Honour, and a member of various scientific societies, said he was at Leeds on May 9th, 1892, with Mr. Swinburne, and inspected the defendant's tramway. He made certain experiments with the view of ascertaining the nature and cause of the disturbances in the telephones, one being to determine whether conduction or induction was the chief cause; the result of that experiment was that conduction played a very small part in it. He made an experiment with a line running parallel to the tramway, and connecting the call office with the station. There was a closed circuit made specially for the telephone going near to the tram line. That was a position for getting the maximum inductive effect without the leakage effect. In that case there was a great noise in the telephone, noise of two kinds, one coming from the tramway generating station and the other from the starting and stopping of the cars. The noise interfered with speaking, but it was possible to carry on conversation. Another experiment was made at the suggestion of Mr. Swinburne. Instead of putting the telephone wire parallel to the line for a short distance, there were put up two wires, one parallel to the other, and crossing from time to time, the return wire being, in fact, twisted round the other. With this there was absolutely no noise. The disturbances generally in the Leeds system were similar to those on all small exchanges where a single wire was used; there was cross-talking and induction from other lines. In the very worst case he tried, conversation was not rendered impossible, but it was necessary to listen with great attention in order not to lose part of the conversation. One could get used to this noise, but it would always be a disagreeable noise. The modifications which would be necessitated in the plaintiffs' system in order to remove the disturbances would be very small ones; it might be done by doubling the wires of some of the subscribers, insulating them from the earth, and by putting in a few transformers. It might be done even without transformers where there was no leakage. When the effects were not inductive but conductive, it was necessary to insulate the double line, otherwise there would be noise. The inductive results could be got rid of on short distances like those at Leeds; he had made experiments in that direction over a period of 12 years.

Mr. BOUSFIELD: May I refer to what was put to Dr. Hopkinson and Lord Kelvin, the suggestion that the subscriber's wire, instead of being earthed at the subscriber's place, should be doubled back along itself and earthed somewhere near the exchange. What do you think would be the effect of that as regards disturbance due to induction on a comparatively short length of line?—The electromagnetic inductive effect would be absolutely avoided, and the electrostatic effects will be so small on lines of two, three or four miles, that it could not disturb.

Judging from your experience, what is the smallest length of line on which an electrostatic effect would be perceptible?—It depends absolutely on the conditions of the lines and of the insulation, the quality of the insulation, and many other things. I have made experiments on various lines in the whole town of Paris, and the electrostatic effect was extremely small. It was necessary to listen with very great care to hear the induction coming from the electrostatic effect; but when I got on the line to Brussels, which is about 17 kilometres in length, and with underground cables, I heard a very great amount of electrostatic effect, so that it was very difficult to differentiate from leakage, as is always the case.

Assuming that disturbance were got rid of by the use of complete metallic returns and transformers on certain circuits, is it practical to work an exchange partly with metallic circuits and transformers and partly without?—Yes; that is an ordinary practice in telephonic work. I have seen it many times, and have worked it myself in that way. I made an experiment on May 10th at the suggestion of Mr. Swinburne, who had to go away from Leeds, which proved that the noise we heard on the telephone line did not come from contact between the trolley and the overhead wire and between the wheels of the car and the rails. I connected the overhead lines, soldered and fixed a long insulated cable, about 100 yards or more in length, and then fixed another to the rail. That completely cut out the con-

tact between the wheels and the rails, and the trolley was also cut out by being removed. I compared the noises in the telephone when the car was running without the trolley with the noises there had been when the car was running with the trolley, and I could not find the slightest difference.

You could not tell any appreciable difference?—No; and the noise that you get from interruption would be quite a different kind from the noise that I heard at Leeds. The noise from interruption would be sharp, short vibrations of the telephone membrane, and the noises coming from the earth at the generating station are musical continuous noises.

Does the word "crackle" express the sort of noise you would get from a varying contact?—A little modified by the induction effect and others, but it would express very nearly what I have heard when contact has been interrupted. I found no noise of that character on these telephones.

You have had experience of telephone systems on the Continent and in America as well as in England?—Yes; in England I have only heard them in Leeds and London, but I have had great experience.

Have you any observations to make on the character of the single wire system which we have heard is adopted by the plaintiffs?—I consider that the telephones that are upon single wire with earth return are not satisfactory instruments, and it is not only my opinion, for at the last International Congress of Electricians the opinion was voted by the Congress that the only way to avoid disturbance is to make all the lines double.

Now as regards the question of tramways, you have spent a good deal of your time in the United States and seen a great many electrical tramways there. Can you tell me from your own personal knowledge what is the result of experience in America as regards the relative practicability of different systems of electrical traction?—There was a road running in Baltimore on the double line, but that was the only one, and the single wire is the general rule almost without exception. The system at Leeds is similar to almost all the electric roads in the United States, about 400 altogether, and it was very well installed.

You have had, for the purpose of this case, to consider the other systems which have been suggested as practicable. Applying that consideration to the case of Leeds, and to the case of the crossing such as shown in the large model, do you consider that any of those systems could be successfully applied under such circumstances?—They have never been applied on such a scale. I cannot answer positively if it is very easily practicable; but I think there will be very great difficulty in making double overhead conductors of such construction as in this model. I went to Vevey at Mr. Leighton's suggestion, and as regards the overhead construction there, I think it would be impossible to put it up in any town, especially for æsthetic reasons; it is a horrible looking thing. It is a double overhead conductor line going from Vevey to Montreux in one direction, with no crossings at all, so far as I can remember. The conductors are tubes slotted, and the current is taken from those tubes by contacts inside. There are turn-outs at intervals for the cars to pass each other; they break the contact, and the car goes by momentum over the turn-outs.

From your observation of that system, and from your knowledge of the requirements of Leeds, do you think that that system is one which could be applied to Leeds for the purpose of electric traction?—It could not be applied to Leeds, for the reason that the road is so complicated; there are so many crossings and turn-outs, that it would make a very complicated system, and would be almost impossible to construct.

There are telephones at Vevey?—Yes; I tested them, and the result was that, although the inductive effects were almost nil, the leakage is sometimes considerable, and the telephone company have been obliged to double the lines going from Montreux to Vevey. I made an experiment on that line, eliminating the metallic return, and so adding induction, and the result was I heard the starting and running of cars, and the running of an electric generator at the station. When the metallic return was used I heard nothing. I have been to Buda Pesth and seen the system there. That is not a complicated system; there are only ordinary crossings there. It runs principally in the centre of the town, through wide streets. The width of the slot at Buda Pesth facilitates enormously the contact with the underground conductor. That system would not be practically successful, applied to Leeds, because it would cost an enormous amount of money in comparison with an overhead conductor system.

Applying your mind to the question of points and crossings with double sets of conductors in conduits, how would that affect the application to a place like Leeds?—In the places I have seen at Leeds it would be very difficult to make connections for double underground conductors; it is not absolutely impossible, because everything in that direction is possible when you spend money enough, but the principal difficulty will be the maintenance of the slot and of all the contacts which must be made and undone in those crossings.

Speaking as a practical engineer, what would be your view as to the adoption of such a system in Leeds?—It would never be proposed in Leeds, because it would never pay.

Cross-examined by Mr. MOULTON: You suggest that it requires a larger slot for electrical underground cables than for tension cables?—A slightly larger one, yes.

In the case of tension cables your connection has to be strong, so that it can take the whole tension of the ropes?—Yes.

There is no strain whatever on the electrical connection, is there?—Yes, friction.

Do you call the amount of friction that there is between the contact pieces a strain?—Yes.

Shall I be exaggerating when I say it is not $\frac{1}{1000}$th part of the strain in a cable tramway?—When it grips it would be exactly the same. It is possible.

With regard to Vevey, you say that the line of the telephone that runs along the tramway has had to be doubled. Is that line for seven miles along the tramway?—I think so.

Is it a trunk line?—It is a line joining Vevey with Montreux.

Do you not know that it is the custom always to have those trunk lines double?—Yes, it is the custom to double. But it is not specially because it is a trunk line in this case, but they have put it up, as they told me, because of induction.

With regard to the interference with that line, it would come from the want of insulation of the telephone wire itself, would it not?—Principally because of the want of insulation of the electric tramway.

But it could not take place unless there was want of insulation in the telephone wire?—Yes, when it is doubled.

You talked about a very small modification of the plaintiffs' system affecting a few lines would make all the difference. If you were to take the line, as in the rest of your evidence you suppose, throughout Leeds, that answer would not be correct, would it? You would have to make much more extensive alterations in order to make the telephone working practicable?—Yes.

Re-examined by Mr. BOUSFIELD: What is the object of doubling a trunk line?—It is for several purposes; first, to avoid induction, because generally the lines are run across long distances between two central stations; and then to have more lines at disposal.

At Vevey, apart from the tramway, do you know that any necessity exists for doubling the wires?—No, there is no necessity; they have used it for many years on a single wire, and they put up the second wire because of the disturbances coming from the tramway.

Do horse trams crossing an electric tramway cause any difficulty?—I do not see any.

Mr. STEPHEN SELLON, M.I.C.E., said he had given a great deal of attention to tramway traction, and designed and superintended the construction of several steam tramways. He had carefully examined the Leeds tramway, and prior to the contract between the defendant and the corporation he was employed to negotiate with the Board of Trade with reference to the system which should be adopted. He was first connected with obtaining the concession, and subsequently connected with obtaining the consent of the Board of Trade. In his opinion, the construction of the line was carried out in a very first-class manner. He was with Mr. Abakanowicz when he made the experiment as to the effect of the contact between the wheels and the rails and between the trolley and the wire. He drew the same inference as Mr. Abakanowicz had done from the result of the experiment, that inference being that the question of contact made no difference at all to the sound in the telephone. He had visited Buda Pesth, and had seen the Blackpool and Northfleet lines. There were no more crossings in Buda Pesth than in an ordinary double system of tramways; there were no complex crossings of any kind on the whole line. There were several crossings at right angles. These did not present any great difficulty, as there was only a very short distance where the contact was broken. The model produced was one which he had prepared to represent the break necessary on the Buda Pesth system where the points ran into an ordinary line, where there was a single line branching out into a double line, or where there was one pair of lines running into another. There was actually nothing like that at Leeds, the model being made to show what would happen if it were more complex. Considerably more than was shown in the model would be required if that system were adopted in Leeds. Witness had great doubts as to whether the break shown in the model could be bridged over by having two brushes, one at each end of the car, as Lord Kelvin had suggested. He doubted whether on a curve such as they had on tramways they would be able to run the collectors within the limits of the car itself. The collectors at each end would overhang the car, which would be against the Board of Trade regulations. The position shown in the model involved a break of 10 feet, and there would be a very serious number of breaks at the particular crossing to which it had reference. If a great many of the difficulties were eliminated from the Buda Pesth system it might be applicable to Leeds, but, to his mind, a great many of them were not easily eliminated, and he did not see how they could be. Speaking as a tramway engineer, the Buda Pesth system was certainly not one which he would apply to Leeds, for many reasons. First of all, there was the objection to the slot; secondly, there was the break of continuity, which would be fatal in Boar Lane, at Leeds; and, thirdly, the question of expense, which in Buda Pesth must have been very large for the construction; he had no idea what that expense was, but it must have been of such a nature as to make it absolutely unfit for a town of the dimensions of Leeds, at any rate for commercial and economical working. The system in Leeds would be very much more complicated than at Buda Pesth. He measured the slot at Buda Pesth, and found that it was $1\frac{5}{8}$-inch. The width of the slot there was due to the fact that they had a metallic return, and consequently, as they had arranged it there, they had to have such a wide slot as to prevent any chance of waste, either by contact with the rails or otherwise. It would be absolutely impossible, under the conditions at Buda Pesth, to reduce the slot. To adopt a modification of Buda Pesth, with a slot of less than $\frac{3}{4}$-inch, would need different modes of collectors. That, again, brought in the difficulty of having a mechanical arrangement outside the car itself, where there was a curve. He had heard Lord Kelvin state that the insulation of the hanger, or the knife that goes through the slot, might be made perfect by means of vulcanite or lignum vitæ, but he was rather inclined to think that that was rather a theoretical plan. They all knew that wood would run very well in connection with iron; they had wooden cog-wheels, for instance, running in iron cog-wheels, but there the friction was reduced to a minimum. In the case of a piece of lignum vitæ running against the rough edge of the rail, it did not apply at all; it would be worn out at once. It was not possible to prevent a certain amount of the swinging motion of the car from side to side, which caused the friction. Even with the $1\frac{5}{8}$-inch slot at Buda Pesth, the knife came in contact with the side of the slot. By reducing the size of the slot there would necessarily be more friction,

which tended to wear away the collector very quickly, the injury to the insulation causing leakage. Using such a collector as was used at Buda Pesth, it would be impossible to have a smaller slot, as the friction would be so great that it would rub away all the insulation. With all the modifications that had been suggested, he did not think the Buda Pesth system would be an efficient system. He certainly did not think the Northfleet tramway presented a way out of the difficulty at Leeds. He had always looked upon the application of the series system at Northfleet as a failure in mechanical working. It failed upon each occasion that he saw it. The nature of the failure in each case was that the spring jacks were knocked down by the plough, and the contact was disabled. The Blackpool system was one of single wires with two conductors of the same polarity, the return being by the rail. That system did affect the telephones in the neighbourhood. He had seen the Birmingham storage battery system, which had not, so far, been a commercial success, the cause being the deterioration in the battery.

Sir RICHARD WEBSTER: Is this your own knowledge, or what you have been told?—This is my own knowledge.

Are you connected with the Birmingham tramways?—I am not.

I should like to know how it is within his own knowledge.

Mr. JUSTICE KEKEWICH: Have you seen the Birmingham tramways?—Yes, I have seen them.

Mr. BOUSFIELD: You have visited them?—Yes, and I know most of the officials in connection with it, and I have also got the report of the Birmingham Central Tramway Company.

Mr. JUSTICE KEKEWICH: We want to know what you yourself have seen, not what somebody has reported.—What I have, in my opinion, to prove the point is the directors' report.

Mr. JUSTICE KEKEWICH: I cannot take the directors' report. Anything he has seen himself, from his own observation, may be useful.

Mr. BOUSFIELD: My learned friend is treating us quite differently from the way we treated him.

Mr. JUSTICE KEKEWICH: Do not complain of Sir Richard Webster. Complain of me. I do not want the directors' report; for aught I know—I do not want to suggest that it is so—it may be a cooked-up report, in order to declare a false dividend. What do I know of it?

Mr. BOUSFIELD: My friend's plan of Buda Pesth may be cooked-up, perhaps, but we have not suggested such a thing. One could not conduct a case if one objected to such things.

Mr. JUSTICE KEKEWICH: You certainly could not conduct a case if you put in directors' reports as accepted statements of facts.

Mr. BOUSFIELD: I will not press the matter after your Lordship's expression of opinion.

WITNESS: Perhaps I should state I know for a fact that they have been using the E.C.C. cells in Birmingham; they have now discarded them, and are now trying another company's so as to, if possible, reduce the expenditure. They are now using the Epstein. I have seen the cars at Birmingham labouring very much under a slight gradient. I went through the town of Leeds myself testing the telephones. They were all soldered and joined to the water-pipes. On certain occasions whilst I was there, there was a great deal of difficulty from conversation, apart from the tramway. In one case I could not talk from the Highways Department at Leeds to Mr. Alfred Cook, the ex-Mayor of Leeds; I could not hear a word, and had to give up the conversation altogether. This was away from the tramway altogether.

Cross-examined by Sir RICHARD WEBSTER: You have criticised several points which I shall have to refer to in Lord Kelvin's evidence on electrical matters, and the evidence of one of the other witnesses. Are you an electrical engineer?—No.

Have you any electrical qualifications?—No more than the fact that I have studied the question of electrical traction since 1885.

I ask whether it is not the fact that when asked questions in the year 1890, as engineer to the Wellingborough Tramroad Bill, you very fairly protested yourself against answering electrical questions on the ground that you were not an electrical engineer?—Quite so.

Have you not on more than one occasion declined to express an opinion when pressed on electrical matters, on the ground that you were not an electrical engineer?—On electrical questions which I did not feel were within my province as a tramway engineer.

When did you make this plan of Buda Pesth?—In August 1892.

Did you not make it for the purpose of showing what were the routes of the steam, the routes of electrical, and the routes of horse trams?—No; my object in making the plan was for the purpose of trying to show if there were any complications in Buda Pesth as regards electrical tramways.

Do you mean to pledge your word to my Lord that you meant to deal with the question of electrical connections?—That was the object of my visit to Buda Pesth.

Did you mean to deal with the question of electrical connections—I am not talking of routes or of crossings?—The object of that plan was to enable me to have, and carry in my mind, an idea of what the tramway at Buda Pesth was.

That is a perfectly general answer, and I am entitled to something more specific. You have given evidence to-day alleging the incorrectness of the plan which I am going to call your attention to presently, and you were asked by Mr. Bousfield whether it was correct having regard to what you saw. Now, again I put it to you, did you prepare this plan with any view of showing what the electrical connections were at the point of junction?—My idea of that plan is that it is a correct representation of what is at Buda Pesth.

Mr. JUSTICE KEKEWICH: You must know, as a man of more than ordinary intelligence, that you have not yet attempted to answer a question three times put.

Sir RICHARD WEBSTER: Do you mean to represent that you prepared this plan in order to show the electrical connections at the point of junction?—No, I did not make it for the purpose of showing electrical connections.

Or to give any information about electrical connections?—For my own purpose.

Will you pledge your word that at that point marked A in the plan before you there are not branches or points as well connecting what I will call the north and south tramway with the east and west?—No, I will not. My plan does not show it.

Will you pledge your word that at the point B there is not also a junction for an electrical tramway between the lines going north and south and east and west?—As far as the road from one tramway to another is concerned.

I am speaking of the means of the tramcar passing round a curve?—There may be that.

Look at point C. Will you undertake to say there is not the same thing there?—There is a horse tramway passing.

Will you look at point C and answer my question. Will you undertake to say there is not a connection by what I will call a loop or a curved line from one line to the other there?—I should doubt it.

Is it not exactly those divergent lines, connecting lines, that create the difficulty from the point of view of electrical connection?—Certainly you would get a point, but what I objected to in the first instance was, you would get a break of continuity.

You produce this model for the purpose of showing the difficulties where you have a curved line running into a straight one, do you not?—Yes.

Is that not exactly the state of circumstances which would create the electrical difficulty?—Yes in a more or less degree.

Why did you not put it on the plan?—I either did not see it or did not pay particular attention to that particular crossing. I made several notes. I have some of them here. I find there is nothing referring to that.

Have you a doubt now that when you prepared that plan you were not thinking about electrical connections at all?—My answer is the same; that the idea of my plan was to give myself an idea of what the system was.

That is not an answer to my question. Have you the slightest doubt that you never thought about electrical connections at all when you were drawing that map?—I do not quite understand your question. My plan was for the purpose of giving myself an idea of what the Buda Pesth tramway system was, and as far as electrical connections were concerned, I simply looked at them individually.

When did you make the model?—Two or three days ago.

Did you put this forward as being a correct model to show the difficulty as an electrician?—No.

Do you suggest, as an electrical opinion, that that model shows an insuperable difficulty?—I am putting that forward as a system of that sort applied on the Buda Pesth system.

Now we will go to another point. I reminded you that you criticised, somewhat hostilely, Lord Kelvin's evidence on one or two points. I am going to take one. You said that the suggestion made by Lord Kelvin that the slot might be narrowed, and that the restoration or re-instalment of any insulated material worn off might be right as a theoretical application; but practically it was all wrong. Have you any personal experience whatever of the working of the sword or electrical conductor through any slot?—I have no practical experience of any conduit system.

You know now that the slot at Blackpool is $\frac{5}{8}$ inch?—Yes, I am aware of that.

Through that slot does there go a sword, or spear, or conductor, or hanger, and is that connected with two insulated conductors of the same polarity, the return being through the rails?—Yes.

Will you suggest why, if the sword can work successfully through the $\frac{5}{8}$ inch slot at Blackpool, it should not work successfully through the $\frac{5}{8}$ inch slot at Leeds?—Well, I have a certain opinion about it.

I did not ask your opinion. Make the suggestion to my lord why it should not.—In Blackpool my idea of the reduction of the slot there is due entirely to the fact that they are able to have two conductors, one on each side of the conduit. If they had not had two conductors, one on each side of the conduit, I think they would have had great difficulty in even getting an electrical connection.

We will enlarge your electrical experience a little bit, perhaps, before we have quite finished; but let me first ask, it will work successfully on a $\frac{5}{8}$ inch slot if you have two conductors to connect with instead of one?

Mr. BOUSFIELD: The same polarity, he said.

Sir RICHARD WEBSTER: I do not care about that. Do you agree that it makes a difference with regard to the working successfully whether it is the same polarity below or not?—I would adopt it, certainly.

Why?—Because if you have that you have then two conductors of opposite polarity coming up between the slot.

Between the slot?—Yes, certainly.

You mean below—underneath?—No, I do not. You have got one conductor going down and another conductor on the return, both coming up between the connection and the car through the slot.

May I point out that if that is the only objection there would be no difficulty, then, in having the conductors of one polarity on one rail, and the conductors of the other polarity on the other rail—two slotted rails instead of one?—Certainly, if you do that you would get the same objection that I have to it now, and that is the difficulty of connection and constant contact between the contact and the conductor itself.

I am sure it is my fault, with your great electrical experience, but you have not understood me. I assume the spear, or hanger, going down in the one rail has two conductors on either side of it of the same polarity, and on the other rail another hanger going down has two conductors on that side of the other polarity. Would you not then get exactly the same perfect contact on both conductors as you get now at Blackpool?—I do not object to the question of contact on both sides.

If you have the insulation worn through of the hanger where the

return is insulated the whole way, is not the whole effect absolutely harmless? Is not the sole object of protecting the insulation of the hanger in consequence of having an earth return?—It is in order to prevent disturbance.

Are you certain that the width you have given was the average width of the slot everywhere at Buda Pesth?—No, I did not go all over the line and try it, I simply took one spot and cut it out on a card.

Will you undertake to say that the slot as laid down is not simply 33 millimetres, or about 1¼ inch?—No, I simply take it from my own knowledge as derived from the template I made at the time.

On the system as now being worked at Leeds, is there anything approaching in complication the points, A, B, and C, shown on the plan?—If this map be correct, certainly not.

As the system is now worked at Leeds is there any existing junction showing the complications of A, B, and C, even on your own map?—Certainly, I think so. At Leeds we have got a double track. Nearly the whole of the line is double track, except a small portion of single. I am speaking of crossings or junctions, and past where the junction of a single line with the double line is there is a cross-over road.

Is the peculiar circumstance there that a single line runs into a double?—No, the point is that you have a cross-over road running from one road to the other.

In the first place, have you single lines running into double as on the Buda Pesth system?—Yes.

Have you cross-over roads at Buda Pesth?—Yes.

It seems to me that is exactly the same state of things?—Yes, I say it is no worse.

Would you tell me of any place at Leeds which is worse than A, B, and C—which was my question—as you know it to exist?—As I know it at Buda Pesth there is no place worse; they are just about the same.

Are you working the Leeds tramway yourself? Have you anything to do with it?—I have a great deal to do with it. I am not an official of the Leeds tramway, but I have been connected with it from its inception.

As a general tramway engineer you have been consulted about the Thomson-Houston system, and not as an electrician?—That is so.

The introduction that was given of you as to your experience in several towns was in connection with horse tramways, steam tramways, and other modes of traction?—I have been connected with the question of the promotion of electrical tramways since 1886.

Boar Lane has not been electrically established yet?—No.

Do you represent that the Northfleet tramway failed in any way in consequence of the slot?—No.

Re-examined by Mr. BOUSFIELD: Does it involve much acquaintance with electrical principles to understand how these cars are driven by a current of electricity supplied to the dynamo by wires outside?—I should think not.

Are you familiar, practically, with the elementary electrical principles on which the running of the lines as shown in the model you have constructed depends?—It is only a small question.

If it comes to a question of electrostatic effect and so on, you would not like to give an opinion?—I should not like to be cross-examined on electrostatic induction.

There are certain places in the map of Buda Pesth where two sets of lines are shown crossing at right angles. My learned friend suggested to you that there are some loops or crossings that would fill in the corners, and permit a car, instead of going right across, to go through from one to the other if necessary. Upon the map that he puts to you, is there the slightest evidence that any such loops or shafts are arranged electrically, with conduits and electrical arrangement, so that the car may be moved round the shaft by electricity?—No, there is not that on that map at all, and I am inclined to think, from my knowledge of what I saw at Buda-Pesth, and I stayed there nearly a week, that a good deal of what is on the map is nearly all composed of red lines. There does not seem to be any difference between what is a horse line and what not; it seems to me the two are confused.

Sir RICHARD WEBSTER: That is not fair. The red lines exactly corresponded with the red lines on his own map. The horse lines are not shown at all.

Mr. BOUSFIELD: Is there anything that your attention has been directed to to show that any such loops or switches as have been put to you by my learned friend are, in fact, worked by electricity, or that the cars would be worked by electricity by those loops or switches?—Certainly not in that map.

From your recollection and examination did you see anything to lead you to the view that there were loops or junctions of that sort which electrically connected these right-angled cross-overs?—I have not seen them.

Did you find at any point connections other than those you have shown worked by electricity?—I think I should have put them in if they had come within my view.

You probably know sufficient of electricity to tell me this: supposing that loops or junctions exist between lines, let us say at right angles, and that those loops were not worked by electricity, but were plain lines over which the car might run; would that create any electrical complications as regards the crossings?—No, not in ordinary tramways, certainly not.

(To be continued.)

EDISON AND SWAN ELECTRIC LIGHT COMPANY *v.* LOTINGA.

ON Friday in last week Mr. Bremner, on behalf of the Edison and Swan Electric Light Company, applied to Mr. Justice Kekewich, sitting in the Chancery Division, for an injunction to restrain Mrs. Lotinga, of Barkston Hall, Earl's Court, from using incandescent lamps, which were an infringement of the plaintiff's patent, adding that they were willing to treat the motion as trial of the action, and so put an end to the matter.

The validity of the plaintiffs' patent (the learned counsel said) had been established by the Court of Appeal after a protracted and costly litigation. The defendant, they had ascertained, was using certain lamps purchased in Berlin, which infringed this patent, and on December 6th they wrote her an intimation of their complaint. In the course of the correspondence which followed, defendant said she had been advised by the firm from whom she purchased the lamps to take no notice of the plaintiffs' application and threat of proceedings, and denying infringement. It was easy (Mr. Bremner went on to say) for these manufacturers to give advice to the defendant, but the plaintiffs had for some time advertised in the *Times* that every incandescent lamp not of their manufacture was an infringement of their patent. At a later date they gave defendant an opportunity of meeting them on fair and reasonable terms, and this having failed they asked the interposition of his lordship.

Mrs. LOTINGA, who appeared in person, said it was true she had bought certain of these lamps, and she had put in the bill to show that this was so, knowing nothing whatever of any patent rights in them. She had been ill for a considerable time, covering the period when complaint was made and indeed when the writ was served, and the correspondence which had been read had come not from her but from a clerk who had acted under instructions from her son, who, however, had no authority to act for or to bind her. When she found what had been done she with her own hands took down three of these lamps, and ordered her son to take down and return the others to the makers. She desired no litigation to take place in the matter, and thought she had been treated with sharp practice.

His LORDSHIP asked Mr. Bremner how many lamps were in question and for how long they had been used; and the learned counsel said their affidavits showed four in actual use, and that 47 were bought.

What damages do you say you have suffered? asked his LORDSHIP; and Mr. BREMNER replied, half-a-crown a lamp.

His LORDSHIP: Very well, say half-a sovereign.

Mrs. LOTINGA said the solicitors wanted 7 guineas as costs and half-a-crown a lamp, and for her to pay any additional costs.

In the result, his Lordship remarked that the motion asked for an injunction restraining the defendant from "making, supplying, selling, or using," the lamps, but this was now reduced to "using," and he thought that a notice in such a matter should be more carefully prepared. A similar remark applied to the order asked for. Having regard to all the facts, defendant not having done what she ought and given way when it was pointed out to her, he should let the injunction go and make it perpetual, but without costs and without damages.

C. E. L. BROWN'S NON-SYNCHRONOUS MOTOR FOR ORDINARY ALTERNATING CURRENTS.

BY A. RECKENZAUN.

AFTER the important discoveries of Prof. Ferraris and Mr. Nikola Tesla, a host of inventors applied themselves to the attempt of solving the problem of a commercial motor which should run efficiently on "ordinary" alternating current circuits. The adjective "ordinary" is used temporarily in this article for the purpose of distinguishing the system presently to be described from the well-known multiphase or "Drehstrom" system. It is not within the province of this communication to enumerate a series of patent specifications relating to alternating current motors, nor to point out whether or not certain ideas have been anticipated by other investigators. My aim is to describe, as far as lays in my power, an ingenious design of an alternating current motor capable of working with two wires on existing circuits, and I am indebted for this information to the inventor, the well-known Anglo-Swiss engineer, Mr. C. E. L. Brown, of Messrs. Brown, Boveri & Co.

Whilst engaged for some time past upon experiments with multiphase machines, Mr. Brown became convinced of the possibility of constructing motors for ordinary alternating currents possessing all, or nearly all, of the characteristics which, until now, have only been attainable by the use of multiphase currents. Among these characteristics of multiphase motors are the following:—

Firstly, and most important, absence of collectors and brushes and consequent simplicity of design and construction.

Secondly, the possibility of starting with a load; and,

Thirdly, non-synchronous running with the various advantages connected therewith.

When we also consider the ease with which alternating currents may be transformed, we can understand why, in all

the recent power transmission and distribution schemes, the alternating current of single or multiple phase has been suggested and employed. There is one disadvantage in the multiphase system, and that is due to the fact that more than two wires are necessary, and this is most apparent in cases of combined distribution of power and light. That there is a great demand for a motor for ordinary alternating currents, of equal simplicity with the multiphase motors, need scarcely be emphasised.

Mr. Brown, in his letter, refers to the real or apparent causes which have hitherto contributed to the failure of alternating current motors. One of these causes, and an important one, was due to the want of attention to the magnetic resistance of the air-gap. Owing to the abnormal magnetising current required, the windings, even while the motor was running light, became so warm that continuous running was out of the question. The efficiency, consequently, was also very low. Mr. Brown has, by placing the wires in holes through the iron cores both of the fixed and rotating parts, entirely overcome this difficulty. Another defect was in the form of the magnetic circuit with projecting poles, which produced injurious reactions in the induced part, rendering the starting of the motor very difficult. Another point deserves attention, especially in connection with American practice, and that is the high frequencies commonly employed. This causes difficulties arising from the great counter-electromotive force of self-induction, as well as from the inconveniently high number of poles required on small motors in order to avoid excessively high speeds. There are other reasons why these earlier experimenters have failed, but those above enumerated are the most important.

I will now describe Mr. Brown's new motor as nearly as possible in his own words, and adopting his own arguments throughout. The principle of this motor is based upon a remarkable phenomena observed by Mr. Brown, viz., that a conductor placed in an alternating field (see fig. 1), if set rotating with a certain velocity, will itself run up to practically synchronous speed, and then tends to keep to this speed against a load. Currents are induced in the conductor by the alternating field. So long, however, as it is at rest these currents are neutral with regard to the inducing field. As soon as the conductor is set in motion this condition ceases, and a turning moment is produced which increases as the speed rises, till synchronism is nearly established. With a conductor in the form of a solid disc the speed will drop more or less below synchronism, depending on the load. With a deeply serrated conductor, on the other hand, or one consisting of few members, the tendency is to preserve synchronous rotation, and if the speed once falls much below this the torque is considerably reduced.

It must also be noted that the direction of rotation is quite indeterminate. The conductor tends always to attain synchronous rotation in the direction in which it was first set in motion. The arrangement shown in the diagram (fig. 1) is, of course, not suitable for practical motors. In

Fig. 1.

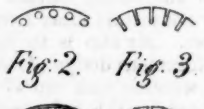


Fig. 2. Fig. 3.

Fig. 4. Fig. 5.

designing a motor based on these facts, the following points must be kept in view. The alternating field must be as strong as possible, and all magnetic resistances (in the inducing as well as in the induced parts) must be reduced to a minimum. Injurious eddy currents, in both iron and copper, must also be avoided as much as possible. These various requirements can be satisfied in the following manner: The inducing winding (*i.e.*, that in connection with the mains), as well as the induced (receiving its current by induction from the former), are provided with iron cores, consisting preferably of iron discs insulated from one another.

In order to reduce the magnetic resistance, the windings are imbedded in iron, either in holes of suitable shape (fig. 2), or between teeth (fig. 3), which may be advantageously closed by a winding of iron wire (fig. 4). The teeth may also, as in fig. 5, be widened, so as to nearly close the opening. Either inducing or induced parts may, of course, be provided with either of these arrangements.

The inducing winding may be, of course, of any of the usual forms, with a suitable number of poles, the sections being connected in series, parallel, or in a combination of both. The induced, which is usually also the rotating part, since sliding contacts are thereby avoided, carries a short-circuited winding, preferably insulated from the core, in order to avoid eddy currents. This short-circuiting may be carried out in various ways. All the ends at each side may be connected together by means of two copper rings, or the conductors may be connected in certain groups, which are separately short-circuited. Or, again, wires similarly situated with regard to the external field, may be separately short-circuited with one another. Another method is to wind the induced part as ring, drum, &c., with a short-circuited connection. For regulating the speed, a resistance, or choking coil, may be inserted in the short circuit.

Figs. 6 and 7 serve to show the most important points

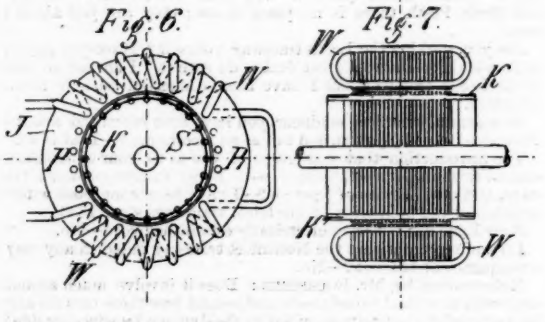


Fig. 6. Fig. 7.

about a motor designed on the above principles. The inductor, J, is shown fixed, and consists of a cylindrical core of laminated iron. The discs, of which it is built up, are perforated near their inner edges and carry the winding, W, here shown as a ring (it could, of course, equally well be wound as a drum). The winding is not shown extending over the whole ring, but there is nothing to prevent its being so arranged. The connections are such that poles are produced at P P'.

The rotating part consists principally of a laminated iron cylinder carrying insulated copper wires, S, in holes close to its circumference. These wires are soldered at each end to stout copper rings, K. A somewhat different arrangement is shown in figs. 8 and 9. This has the property, described at first, of almost synchronous running.

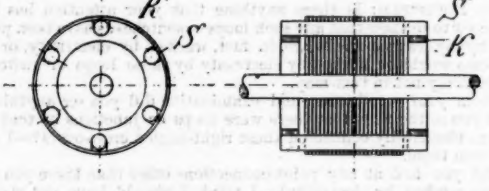


Fig. 8. Fig. 9.

Here, again, copper conductors, S, are bedded in a laminated iron core and soldered on both sides to stout copper rings, K, the only difference being that the number of conductors is here very small.

Figs. 10 and 11 show another type of rotating induced part, provided with a ring winding, S. Two opposite points are here connected to sliding contact rings, so that a resistance for regulating the speed may be readily inserted.

A motor constructed according to the above principles and suitably proportioned, has a remarkably high weight efficiency. Mr. Brown has designed a non-synchronous motor, for example, weighing only 150 kg., which, at about 2,000 revs., could be loaded to 6 H.P. without excessive

heating. Its efficiency is very good, and the apparent watts are but very slightly more than the true watts. The outside dimensions of the motor without pulley are: Length (along shaft) 430 mm., greatest height 350 mm., greatest breadth 340 mm. These figures suffice to show that the output of this form of motor is scarcely behind that of one for direct or multiphase currents.

Fig. 10.

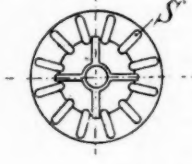
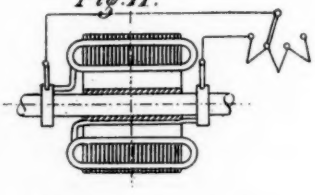


Fig. 11.



Mr. Brown briefly touches upon an important point, viz., the pre-determination of the so-called "idle" or magnetising current; as it is, of course, necessary in designing a motor to be able to calculate this current.

Experiments with a large number of motors of various outputs show that this may be done with sufficient accuracy for practical purposes, the observed currents differing in most cases by only a very small percentage from their calculated values.

The same principles hold here as in the design of ordinary dynamo machines.

A convenient formula for determining the necessary values is that of Kapp (in his paper on "Alternate Current Machinery"). It is as follows:—

$$v = c \sim L\,w\,10^{-8},$$

where v = electromotive force,

c = a coefficient expressing the ratio between the E.M.F. of alternate and continuous current machines. In the above-mentioned paper will be found the values of c for various cases commonly occurring in practice.

Herr Görges has extended this table, giving values for other cases (*Electrotechnische Zeitschrift*, 1892).

$\sim$ = number of complete cycles per second.

L = total number of lines per pole.

w = total number of wires in the inducing part.

By substituting the values of v, c and w, we may find L, the total induction, and thence the density of the lines, both in the fixed and rotating parts, as well as in the air gap separating them. The mean length of the lines is taken at once from the drawing; and from these data, by the well-known method of Hopkinson, the ampère turns necessary to produce this magnetisation can at once be found. The number of wires being given, we thus have the value of the idle or magnetising current.

Having found the current required to run the motor idle, we may easily determine with sufficient accuracy that required with a load. We may do this as with transformers having open magnetic circuits, since in both cases the idle current lags 90° behind the working current. We have the following equation:—

$$\text{Resultant current with any load} = \sqrt{I_i^2 + I_w^2}.$$

Where I_i = idle current,

and I_w = working current.

If, for example, a motor takes 30 ampères idle current and 100 ampères working current, we have for the resultant current $I = \sqrt{30^2 + 100^2} = 105$, about—that is, but few per cent more than the working current.

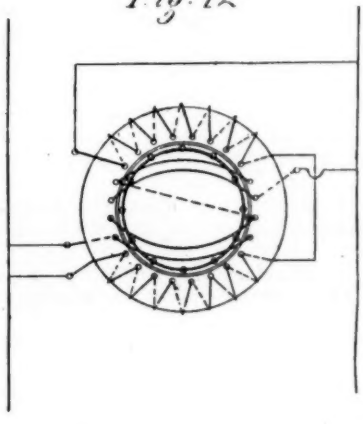
As regards induction in the iron, current density in the copper, &c., similar rules apply as for ordinary dynamo design.

As it would have occupied too much space to go at length into all the questions involved in the calculations for these motors, Mr. Brown has merely sketched out the broad principles upon which they rest, wishing especially to point out that the calculations for such motors are similar to those which have long been in use for direct current machinery. The reasoning applies equally to multiphase motors, and, in fact, it should be clearly understood that, with both broad types of motors, the same principles apply throughout.

A motor designed in accordance with the principles described above has similar properties to a multiphase motor, *i.e.*, has no collector, runs non-synchronously, and, as far as efficiency and output are concerned, is also very similar. In one respect only does it differ considerably from a multiphase motor, viz., it will not start itself, and some method must therefore be found of neutralising this disadvantage. There are various ways of doing this.

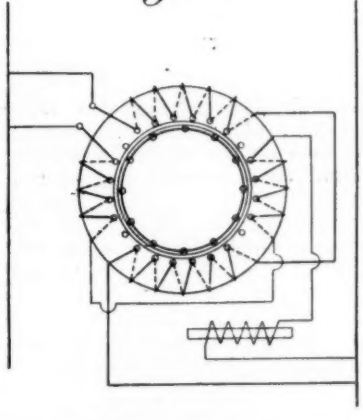
The motor may, for example, be provided with a second winding, wound in the spaces of the first, and which, being only a short time in action, may be of relatively small section. By giving this winding a different self-induction to the first, and connecting the two in parallel, the resulting phase-difference produces a rotating field starting the motor and bringing it up towards synchronous running. This

Fig. 12.



second winding can now be cut out and the motor continues to run as single-phase motor as above-described. The difference of phase in this second winding can be attained in various ways. One method is to wind one section as drum and the other as ring, as in fig. 12, as it is well known that the latter has considerably greater self-induction than the former.

Fig. 13.

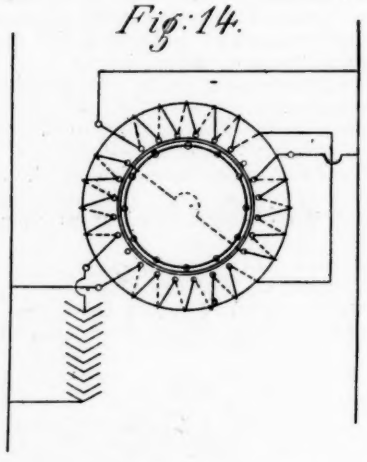


We may further attain the same end by connecting a self-induction (fig. 13), or capacity (fig. 14), or a resistance in series with one section. This method may, of course, be used in conjunction with the above-described mixed winding. In order to obtain conveniently the necessary capacity we may use a series of elements, which Messrs. Stanley and Kelly have also lately employed in their experiments with alternate current motors. A very convenient form of water capacity consists of a large number of iron discs dished out to a conical form, piled together with insulating distance pieces to allow room for the liquid. (See figs. 15 and 16.) A solution of soda in water may be employed for filling.

As a further method of obtaining the necessary difference of phase, suitably proportioned transformers may also be employed.

By means of this difference of phase, in a suitably proportioned motor, a very considerable starting torque may be

Fig. 14.



obtained. Thus Mr. Brown has succeeded in getting, with a 1 H.P. motor, a torque corresponding to a load of 3 H.P. at full speed.

Another method of starting single-phase motors consists in providing the induced, usually the rotating, part with a

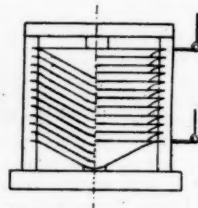


Fig. 15

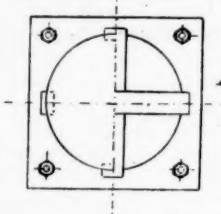
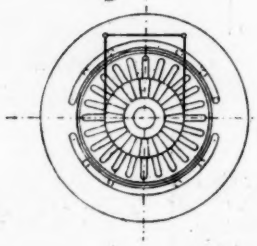


Fig. 16

winding connected with a collector (figs. 17 and 18.) By means of suitable brushes we may either supply this winding with current from outside, or the brushes may simply be short circuited. As soon as the latter are in their proper

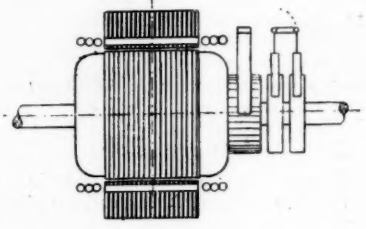
Fig. 17



position with regard to the external field, a powerful torque is produced, and the motor starts. As soon as a sufficient speed is attained the collector may be short circuited by means of brushes pressing on contact rings connected with opposite points of the winding. Or the winding may be short circuited by means of a conducting ring brought into contact with the collector. The motor then works in the manner described above. In this case the inducing part is wound in the simple normal manner, *i.e.*, it requires no second winding, for the purpose of obtaining a difference of phase. On the other hand, the induced part has, instead of its simple short circuited winding, a drum or ring winding, or it may be wound like the armatures of the Thomson-Houston or the Brush arc light machines.

Mr. Brown asserts that these non-synchronous motors for ordinary alternating currents may be built of any size, from

Fig. 18



quite small types to machines of 100 H.P. and more. There seems no doubt that in this system we find the means of securing the long-looked-for extension of the use of ordinary alternating currents to purposes of the transmission and distribution of power, especially in conjunction with electric lighting. For power distribution alone the multiphase system will still hold its own. Mr. Brown promises more detailed descriptions at an early date, pending certain questions which have yet to be settled in patent offices. The present description will suffice to give a general idea of the subject, and it will interest those whose aim it is to promote the welfare of the electrical industry.

CORRESPONDENCE.

Electrical Engineering and Litigation.

The following letter came to hand after our Correspondence columns had gone to press:—

In your leading article "Electrical Engineering and Litigation," in your issue of 20th instant, you state: "In the Swan-Edison lamp case there was a delay of eight or nine years before any action was taken." Permit me to say that this has been written under an entire misapprehension. Mr. Edison's key patent is dated November 10th, 1879; lamps made under the patent were introduced into England "on or about March 23rd, 1880." But very little movement took place in electrical matters till the Paris Exhibition in 1881, and the Edison Electric Light Company was not formed in London till March, 1882. A few weeks after the establishment of the Edison Company, they commenced an action for infringement against the Swan Company. I have before me the copy of an affidavit in that action, which was sworn on July 27th, 1882. You will thus see that an action for infringement was commenced at the earliest opportunity.

It is a matter of common knowledge that one of the results of the then pending litigation between the Swan and the Edison Companies was that the Edison and Swan Company was formed in October, 1883.

Naturally a great many pressing questions had to be dealt with by the amalgamated company, amongst others that of the firm or company against whom legal proceedings for infringement should be taken, and after mature consideration it was determined to proceed against Messrs. Woodhouse and Rawson. This conclusion was arrived at in October, 1883, the very month in which the company was formed.

Negotiations with Messrs. Woodhouse & Rawson led to some further delay, but the case was pressed on so soon as these negotiations for settlement failed.

You also say "these delays are undoubtedly beneficial to the patentee." Pardon my differing *in toto* from that expression of opinion. In the Edison and Swan case certainly it has been the exact contrary. Until the first legal decision was given in favour of Edison's patent, manu-

facturers infringed freely, and the public bought a fair number of infringing lamps.

It would have been in every way beneficial to the Edison and Swan Company to have obtained a decision at the earliest possible moment, and we were at all times anxious so to do. Our line of argument was, if the patent is valid, the sooner it is so pronounced the better for our shareholders; if invalid, the sooner we know it the better, so as to prepare for the inevitable competition. You will therefore see that there was no delay in setting the law in motion.

We have always had before us the desirability of endeavouring to pay our shareholders a dividend of 7 per cent. per annum from 1883, and then reducing the price of the lamp. That we shall only have been able to attain this moderate success towards the end of the protected period has been due to the protracted litigation which we have had to sustain.

S. Flood Page.

January 25th, 1893.

NOTES.

Our American Contemporaries.—We have received a copy of the Christmas number of *Dixie*, which is a monthly journal, published at Atalanta, Ga. The electrical department, we understand, is in the charge of Mr. F. W. Willcox, who contributes regularly articles on electrical subjects.

Electric Interlocking.—We understand that the Great Eastern Railway Company have decided to adopt—and the work has been commenced—a complete system of electric interlocking (Sykes), with all the latest improvements, on all the company's suburban lines within Tottenham on the Cambridge line and Ilford on the Colchester line. They have also under trial an invention of Mr. Hollins, applicable to the remainder of the Great Eastern Railway. Their block apparatus is Tyer's, and Mr. Hollins has covered up the plungers with a brass case, and has interlocked a covering screen with the starting signal, so that after the signalman has given "Line clear" for a train, he cannot again give "Line clear" for a following train until his starting signal has been lowered and put to danger behind the train. This invention is applicable to all kinds of apparatus.

University College, Nottingham.—The engineering courses at this Institution, as arranged by Prof. William Robinson, are well calculated to give the students such a scientific and technical training, directly bearing upon industrial work, as will fit them to enter the factory or workshop with a thorough grip of the principles underlying their work. Special facilities are offered to students in electrical engineering, particulars of which are given in the College Calendar for 1892-93.

Reading Electric Lighting.—The Town Council, last week, passed a resolution consenting to the granting of a provisional order by the Board of Trade to the Reading Electric Supply Company in respect to the Borough of Reading.

Bills in Parliament.—Among the private Bills which passed the Examiners at the House of Commons last week were the following:—The Edinburgh Corporation Tramways Bill, which, among other things, is to authorise the use of cable or electrical power on the lines belonging to, or to be acquired by, the Corporation; a Bill for confirming an agreement for the transfer to the Kensington and Knightsbridge Electric Lighting Company, Limited, of the undertaking of the Chelsea Electricity Supply Company, Limited. There were also three Bills referring to the construction of electrical subway railways in London. They were, one for a line running from Kilburn along the Edgware Road to Victoria, the proposed capital being £1,200,000, with £400,000 borrowing powers, and one for a subway from Clapham Junction to Paddington, with a subway to the Royal Albert Hall; the other was a Bill extending the time for the purchase of lands, and for the completion of the extension of the City and South London Railway from Stockwell to Clapham.

Cardiff Electric Lighting.—It is expected that the electric light will be ready for supply at Cardiff during the autumn of this year.

Huddersfield Electric Lighting.—Two thousand pounds is to be expended for painting and redecorating the Town Hall, and fitting same up for electric lighting.

Hull Electric Lighting.—Extensions are to be made at Hull. The electrical engineer is preparing an estimate of the cost of carrying distributing mains through Whitefriargate Bridge to the furthest point of supply; tenders are also to be advertised for for the execution of the necessary work.

Derry Electric Lighting.—The loan of £15,000 for electric lighting purposes has been sanctioned by the Local Government Board.

Electric Lighting of the British Museum.—A *Times* correspondent complains of the inefficiency of the electric lighting of the British Museum Reading Room. He states that "An hour seldom passes without one or other of the lamps going out and so plunging many students into semi-darkness, while the loud and continuous hissing made by all of them is a serious interruption to steady work."

Multiphase Lighting and Power Distribution.—Messrs. Siemens and Halske, of Berlin, in conjunction with the Helios Company, of Cologne, are now erecting what they term the largest "Drehstrom" installation. The directors of the Royal States Railways of Saxony have determined to provide a central station which shall generate the power necessary to supply all the railway stations in Dresden with electric light and motive power. The ultimate capacity of the central station will be upwards of 1,300 horse-power. There will be installed five steam boilers and four steam engines of 330 H.P. each, driving an equal number of multiphase generators at a speed of 100 revolutions per minute. These generators are to give 120 volts, which will be transformed up to 3,000 volts for transmission, and again transformed down to suitable pressures at the points of distribution. The transmission network will cover a distance of 7 kilometres, and there will be immediately supplied 600 arc lamps and 3,000 glow lamps. Messrs. Siemens and Halske provide the entire central station equipment and the multiphase motors, and the Helios Company will lay the mains, furnish transformers, and instal all the lamps and their fittings.

The Electric Club of Victoria.—With this name a club has been formed at Victoria. We understand that forty-five members have already been enrolled, and the club shows every sign of becoming a great success. The inaugural dinner was held last month, when a very pleasant evening was spent. It is the intention of the members to spend the summer months in excursions (one each month) to interesting electrical installations, and in the winter to settle down to papers and discussions. The club embraces representatives from the University, the Government Railway Department, General Post Office Department; the Supply Companies, importers, agents, electrical engineers, consulting electrical engineers, and other persons interested in electrical matters.

Bilston Market Electric Lighting.—Some of the stall-holders, says the *Birmingham Daily Post*, in the Market Hall have presented a petition to the Commissioners complaining of the insufficient light given by the electric lamps. In this memorial it is pointed out that unless the electric light can be improved it will be best to revert to gas.

Important to Electric Light Consumers.—In the Westminster County Court, on Wednesday last, the case of "The Metropolitan Electric Light Company *v.* Nathan" came before Judge Bayley. Plaintiffs claimed £3 17s. 6d. for 128 units of electricity supplied. The defence was that the amount charged for was more than was consumed. Plaintiffs said, under their Act of Parliament, the meter index was conclusive. Whatever the meter registered the consumer was liable for. Judgment was given for the plaintiffs for the amount claimed, with costs.

Wakefield Electric Lighting.—The City Council have appointed a sub-committee to consider the desirability of adopting the electric light for the city.

Preston Electric Lighting.—In regard to a statement made by Alderman Lancaster that there had been a partial failure of the electric light at Preston, the National Electric Supply Company communicated with this gentleman, saying that there had been no failure whatever. Alderman Lancaster has replied, regretting the error he made when referring to Preston. Copies of the letters appear in the *Preston Herald*.

Society of Arts.—Prof. Fleming, F.R.S., will deliver on Monday evening, 30th inst., the first of a course of Cantor lectures on the "Practical Measurement of Alternating Electric Currents," and the lectures will be continued on the following three Monday evenings. The lecturer will deal with the "Measurement of Alternating Current Strength" on January 30th; with "Alternating Current Potential" on February 6th; with "Alternating Current Power" on February 13th; and with "Alternating Current Energy" on February 20th.

Sandgate Electric Tramway.—A meeting is to be called to consider whether it is desirable to run the tramway by electricity.

Central and South American Cables.—The ss. *Silvertown* left the Thames on Sunday the 23rd inst. for the West Coast of South and Central America. She has on board 2,622 knots of submarine cable for duplicating the Central and South-American Telegraph Company's system, between Chorillos (Peru), Santa Elena (Ecuador), San Juan del Sur (Nicaragua), and Salina Cruz (Mexico). The expedition is in charge of Mr. Matthew H. Gray.

Interruption of Telegraphs.—The Eastern Telegraph Company notify delay to all parts of Egypt, with the exception of Alexandria, caused by the interruption of the Egyptian land lines through bad weather. The service was restored yesterday.

Molecular Volumes and the Degree of "Ionisation" of Salts.—J. Traube, whose researches into electrolytic problems we have frequently noticed during the past two or three years, has recently been comparing the molecular volumes of a large number of salts in aqueous solution, as found by different investigators, with the degree of electrolytic dissociation or "ionisation" of the salts, and finds that a very close relation exists between the two. G. C. Schmidt (*vide Monatshefte*, xi., p. 35) noticed also a relation of this kind in a research on the change of volume which accompanies the solution of salts in water, and stated it in the form of an equation. He was of opinion that the molecular volumes of electrolytes are made up of two constants, one of which depends upon the positive and the other on the negative ion. Arrhenius has shown, too, that in a dilute solution the molecular volume of an electrolyte should be an additive function of those of its two ions. Ostwald has agreed that the numbers considered by Traube cannot simply represent molecular volumes of the dissolved substances, inasmuch as they are in certain cases negative; but to this objection Traube replies in a paper which may be consulted in the *Berichte der Deutschen Chemischen Gesellschaft*, xxv., p. 2,524, that in all such cases the salts contain water of crystallisation, and that when allowance is made for the contraction of the atter, the negative value disappears and numbers are obtained which correspond with those of the anhydrous salts.

The Portsmouth Electric Lighting.—During the last few weeks complaints have been very rife as to the insufficiency and bad quality of the gas. Consequently, traders and others are eagerly anticipating the introduction of the electric light.

Chatham Electric Lighting.—The Chatham Town Council have resolved to send a letter to the electric lighting company, asking if they were willing to part with their undertaking to the municipal authorities, and, if so, upon what terms.

Lectures.—Mr. Newman Laurence, M.I.E.E., lectured (with experiments) upon "Electricity Within Us" before the New Somerville Club (Ladies) on Tuesday, the 17th inst.

Mr. T. S. Watney last Monday lectured on the subject of "Electric Lighting" before the Leeds and Yorkshire Architectural Society.

Glasgow Electric Lighting.—A preliminary trial run of four engines and dynamos was made a few days ago at the new electric lighting station in Waterloo Street, Glasgow, and proved satisfactory in every respect.

Accident.—According to the *St. James's Gazette*, Mr. Thompson, a cashier of the Northern Bank, Coleraine, was killed at Portrush, on Monday last, by a car upsetting and falling on him.

Croydon Electric Lighting.—Mr. W. H. Preece has drawn up a statement as to the cost of an installation for the supply of electricity to the new Town Hall and Free Library, also of sufficient capacity to supply consumers within the compulsory area. The cost of a separate installation for the Town Hall he estimates at £3,500. For supplying throughout the compulsory area, in addition to the number of lamps to be fixed at the Town Hall, there would be at least 6,000 8-C.P. lamps taken up, and for this a central station would have to be provided, the capital cost of which would be about £15,000. The proposed charge is 7d. per unit. The Croydon County Council have referred the matter back to the General Purposes Committee.

Kingston Electric Lighting.—A meeting of the Ratepayers' Association was held last week, to discuss the decision of the Corporation to apply to the Local Government Board for a loan of £16,000 for electric lighting a portion of the borough. There were, however, such a few persons present, that the question was adjourned.

York Electric Lighting.—Seventeen tenders have been received for the electric lighting of the city. Prof. A. B. W. Kennedy has been appointed consulting engineer.

Kensington Electric Lighting.—The Works Committee of the Vestry, at their last meeting, considered the following notices and plans received from the electric lighting companies relative to the extensions of their mains:—House-to-House Electric Light Supply Company, Limited, extension of mains in Creswell Gardens; and Kensington and Knightsbridge Electric Lighting Company, Limited, extension of mains in Emperor's Gate and Grenville Place. Permission has been given for the works to be proceeded with, subject to their being carried out strictly in accordance with the directions to be given by the Vestry's surveyor, and under his supervision.

South Wales Electric Lighting.—The village of Brynmenin was last week lighted by electricity for the first time.

Newcastle Electric Lighting.—Mr. Lamb, lamp inspector, has just drawn up a report regarding street lighting in Newcastle.

Hammersmith Electric Lighting.—At the last meeting of the Hammersmith Vestry, it was stated, in regard to the electric lighting, that the necessary documents had been deposited, together with the draft provisional order, with the Board of Trade. No objections have yet been received.

Edinburgh Electric Lighting.—The Lord Provosts' Committee of Edinburgh Town Council had a meeting on Saturday last in conjunction with the members of the electric lighting deputation, and after finally adjusting and verbally amending in one or two minor particulars the report, gave instructions for its being circulated amongst members of the council.

Ipswich Electric Lighting.—The Ipswich Borough Electric Lighting Order has been revoked by the Board of Trade, dating from 17th inst. There is now no authority in Ipswich to supply electricity.

Irvine Electric Lighting.—An examination has been made as to whether a neighbouring mill can be utilised for lighting the streets with electricity.

The Pacific Cable Scheme.—The Melbourne Chamber of Commerce has declared itself in favour of proceeding with the Pacific cable. The Chamber maintains that the New Caledonia and Queensland cable does not form a part of the scheme.

Engineering Conference at the Post Office.—There will be a conference of all the superintending engineers of the Post Office Telegraphs, under the presidency of the Engineer-in-Chief, Mr. W. H. Preece, at the General Post Office to-day (Friday). We understand that the various problems that have arisen in connection with the heavy copper lines about to be erected by the department for trunk telephone purposes will largely engage the attention of the conference, and it is probable that important constructional decisions will be arrived at.

Electric Launches at Southport.—On Wednesday last, Lord Coleridge and Mr. Justice Charles quashed the conviction against the Southport Corporation for having an electric launch on the Southport foreshore lake, for the conveyance of passengers, without a certificate, under the Merchant Shipping Act, 1854. Their Lordships said it was absurd to think that a small electric boat on an artificial piece of water was ever intended to come within the Act.

Electric Lighting of Nelson.—It is not two years since the Corporation of Nelson received their charter, yet in this time they have introduced the electric light into the borough. The supply was commenced at the end of last month. The central station at present contains one central valve steam engine capable of generating 80 I.H.P. at 460 revolutions per minute, the armature of the dynamo is coupled direct to the crank shaft, the dynamo and engine being upon one cast iron base, the capacity of the dynamo is 360 ampères at 120 volts, the fields are plain shunt wound and the armature is of the drum type, the magnets are of wrought iron, the winding itself being carried upon separate shells which are slid upon the wrought iron cores. The steam is generated principally by means of hot air passing through the gas retorts (otherwise, waste heat), the hot gases being passed between the tubes of an ordinary boiler, the capacity of this heat is sufficient to raise ample steam for the present engine at 80 lbs. pressure. The switchboard contains the the necessary voltmeters for taking the pressure at various points, also ammeter main switches and main cut-outs, all mounted upon enamelled slate, and the whole upon polished walnut. The distributing mains are on the 2-wire system, and are insulated with vulcanised rubber to 600 megohms; they are carried upon vitrified porcelain bridges in cast-iron conduits. Distributing and tapping boxes are placed at intervals in the usual way. The sub-mains are of the same insulation and are carried inside from tubes lined with glass. The insulation test on completion was 6 megohms. The majority of the shops have adopted the electric light, which the Corporation have offered to supply at cost price for 3 years. The centre of the town is lighted with arc lamps. The station has been designed and the work carried out by Mr. Thomas Barton of Blackburn.

NEW COMPANIES REGISTERED.

Baily, Grundy & Barrett, Limited.—This company was registered on the 18th inst. with a capital of £10,000 in £5 shares, to acquire and take over as a going concern the business now carried on by Robert Major Baily, at 2, St. Mary's Passage and Magdalen Street, in the borough of Cambridge, under the style of Baily & Grundy, and all or any of the liabilities, to carry on the business of electricians, mechanical engineers, and manufacturers, workers and dealers in electricity, motive power, and any business in the application of which electricity or any light power; to accumulate electricity and electromotive force or any other similar agency, and to supply the same for transmission or use. The subscribers are:—A. Barrett, Cambridge, electrical engineer, 240 shares; E. Barrett, Cambridge, china dealer, 80 shares; W. E. Lilley, Cambridge, warehouseman, 160 shares; J. L. Smith, Cambridge, tea merchant, 60 shares; W. J. Crampton, Cambridge, electrical engineer, 1 share; W. A. Matthew, Cambridge, solicitor, 1 share. Until otherwise determined the subscribers to the memorandum of association are to be the first directors. Qualification, £100. Registered office, 2, St. Mary's Passage, Cambridge.

Herculite and Electrical Manufacturing Company, Limited.—This company was registered on the 11th inst. with a capital of £12,000 in £1 shares, to enter into a specified contract and to carry on in the United Kingdom and elsewhere the trade or business of manufacturers of and dealers in the moulded article, for the compound of which Mr. Jos. Lang has taken out a provisional specification for patent 3,240, and to manufacture or otherwise deal in any materials, machinery, apparatus, appliances, articles, or things required for the above object. The subscribers (with one share each) are: C. S. Moore, engineer, Cheyne Walk, S.W.; G. W. Willock, gentleman, Kensington; S. E. G. Lawless, captain, R.A., Woolwich; J. A. C. Lawless, gentleman, 63, St. James's Street, S.W.; F. D. C. Strettell, gentleman, Surbiton Hill Park; T. Lurge, clerk, Teddington; S. C. Lewis, clerk, 38, Vicarage Road, Tottenham. The number of directors is not to be less than three nor more than five; qualification, £250; remuneration, £300 per annum and percentage. Registered by Saunders, Bennett & Co., 68, Coleman Street, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Western Counties Electric Light and Power Syndicate, Limited.—The statutory return of this company has just been filed as made up to September 9th. It appears that 41 ordinary shares of £50 each have been taken out of a capital of £25,000, and that the full amount of calls has been paid.

London Electric Wire Company, Limited.—The statutory return of this company, made up to October 6th, has been filed at Somerset House, and shows that out of a capital of £50,000 in £5 shares, 4,138 preference and 4,451 ordinary shares had been taken up, of which 3,860 of class have been issued as fully paid. The full amount has been paid on the remaining shares, resulting in a total of £4,345.

Woodfield Syndicate, Limited.—The annual return of this company, made up to January 2nd, 1893, shows that out of a nominal capital of £12,000 in £1 shares, of three classes, the whole amount has been taken up, with all the calls paid in full.

Aurora Electric Lighting and Distribution Company, Limited.—The first annual return of this company was made up to October 11th last, and shows that 40 shares out of a capital of £25,000 in £1 shares have been taken up. The full amount has been called on the first 25 shares, resulting in a payment of £35. No call has been made upon the remaining shares. By an agreement, dated January 2nd, 1893, the company agreed to allot to Mr. C. J. Fox, 5,000 fully paid shares for his past valuable and efficient services.

Herculite Manufacturing Company, Limited.—The shareholders of this company resolved at meetings held on November 17th and December 12th, that it would be advisable to reconstruct their company, and that it should be wound up. Mr. E. J. Lunnon was appointed liquidator. The new company, under the name of the Herculite and Electrical Manufacturing Company, was registered on the 11th inst.

Birmingham Telegraph Factory, Limited.—The annual return of this company has been made up to December 8th, 1892, and shows that out of a nominal capital of £50,000 in £10 shares, 707 shares have been taken up, of which 400 were issued as fully paid. The full amount has been called, resulting in the payment of £3,010. There is still £60 in arrears.

Kennedy Storage Battery Company, Limited.—The statutory return of this company has been made up to December 15th, 1892, and shows that all the capital of £100,000 has been taken up and allotted as fully paid.

Electric Trust, Limited.—The annual return of this company has been made up to October 19th last, and filed at Somerset House. There have been 1,675 £10 and 167 £1 shares taken up, upon which the full amount has been called. The total amount of calls received is £16,917.

Electrical Company, Limited.—The statutory return of this company, made up to November 25th last, was filed on the 10th ultimo, and shows that out of a nominal capital of £15,000 in £5 shares, 3,000 shares have been taken up, with £1 called on each. The total amount of calls received is £3,000, and £9,000 has been agreed to be considered as paid.

Electric Lamp Company, Limited.—The statutory return of this company has been made and shows that out of a capital of £4,000 in £1 shares, 2,797 have been taken up, with the full amount called on each. There has been £50 paid, £2,690 has been agreed to be considered as paid, and £57 yet remains outstanding. The registered office of the company on September 28th, 1892, was situate at 26, Thavies Inn, E.C.

Electric Clock Company, Limited.—The statutory return of this company has been filed at Somerset House, and states that out of a capital of £1,200 in £1 shares (1,170 ordinary shares and 30 founders') 7 shares have been taken up. Nothing has either been called or paid.

Foreign and Colonial Arc Accumulator Company, Limited.—The registered office of this company is situate at 19A, Coleman Street, E.C.

Foreign Electric Date and Time Stamp Company, Limited—The registered office of this company, according to a notice filed at Somerset House, is situated at 20, Bucklersbury, E.C.

Freedman Battery Company, Limited.—The registered office of this company is at 66, Berners Street, Oxford Street, W.

CONTRACTS OPEN AND CLOSED.

OPEN.

Blackpool.—January 26th. For the following works required in the erection of a new electric light station for the Council, viz., bricklayer (labour only), stonemason (labour and materials), joiner (labour and materials), and plumber, painter and glazier (labour and materials). Plans and specification may be seen, and bill and quantities obtained, on application to Mr. J. Wolstenholme, borough surveyor, Town Hall, Blackpool. Tenders to be delivered at the Town Hall by 26th inst., endorsed "Tender for New Electric Light Station."

Dundee.—It has been decided to obtain tenders for lighting the Old Steeple and the Police Office, as extended, by electricity.

Nottingham. — February 16th. For the supply and erection of boilers at the electric station, Wollaton Street. Further particulars in our advertisement pages.

CLOSED.

Dundee.—The tender of Messrs. James Maxwell & Sons, for the fitting up of the Town House for electric lighting for the sum of £140 has been accepted. The offers ranged from this figure up to £260.

BUSINESS NOTICES, &c.

Conversazione.—The second annual conversazione of the New Telephone Company's Manchester district was held at the offices, 102, Portland Street, on Friday evening, the 20th inst. There was a large attendance of *employés* and friends, and a very enjoyable gathering was brought to a successful termination in the early hours of the morning. A long and varied programme of vocal and instrumental music was effectively rendered.

Australian Electric Light, Power and Storage Company, Limited.—Mr. J. H. H. Duncan and Mr. B. H. Van Tromp have been appointed liquidators of the above company, at 39, Coleman Street, E.C.

The City Electric Lighting.—Since our last report we note that electric lighting contracts have been carried out in the London and Provincial Marine Insurance Company's office, Royal Exchange; in the premises of Messrs. Dombey & Sons, Cannon Street; one for Mr. Wordley, jeweller, &c., Cannon Street.—Messrs. Fuller & Tate, of Bucklersbury, have a large amount of work at present in hand, including the fitting up of the offices of the Indemnity Marine Company, Threadneedle Street.—A contract for fitting up the premises of Mr. Hodgkinson, Queen Victoria Street, and one at 56, Moorgate Street, E.C.—Messrs. J. G. Statter & Co., Westminster, are engaged in the offices of the Ocean Marine Insurance Company, Limited, Old Broad Street.—Messrs. Vaughan and Brown are carrying out work in the printing works of Messrs. Scriven, Fleet Street.

Notice is given by the City of London Electric Lighting Company that, unless unforeseen circumstances arise, electric energy will be laid on within the next few months in the areas specified below: 1. Nicholas Cole Abbey sub-area, bounded on the north by St. Paul's Churchyard and Cannon Street, east by Friday Street and Bread Street Hill, south by River Thames, west by St. Andrew's Hill and Creed Lane. 2. Finsbury Circus sub-area, bounded on the north by South Place, Eldon Street, and Liverpool Street, east by Bishopsgate Street Without, south by London Wall and Wormwood Street, west by Finsbury Pavement. 3. Salisbury Square sub-area, bounded on the north by Fleet Street, east by New Bridge Street, south by the Embankment, west by the City boundary. 4. Billiter Avenue sub-area, bounded by Leadenhall Street, Fenchurch Street, and Gracechurch Street. 5. Farringdon Street sub-area, bounded on the north by Holborn Viaduct, east by Old Bailey, south by Ludgate Hill, west by St. Bride Street, Shoe Lane, and St. Andrew's Street. Early application should be made to the company by those who wish to receive the current.

Electric Lighting in the West End.—Since our last report we notice that a further large number of new contracts have been taken in hand in this district, among which we may mention fitting work in Trafalgar Buildings, Northumberland Avenue, which is being carried out by Messrs. Laing, Wharton & Down.—A new building, part of which will be occupied by the Manchester Fire Office as the West End branch, is being erected in Pall Mall; the building is to be lighted throughout by electricity.—Messrs. Vaughan and Brown are carrying out some electric lighting work at the Globe and Prince of Wales's Theatres.—Contracts have recently been carried out in the premises of Messrs. Arthur Cobbett & Sons, 19, Pall Mall; in the new premises in King Street occupied by the Netherlands Gallery; in Sweetland's dairy, Jermyn Street; and one in the premises of Mr. J. Solomon, fruiterer, 69, Piccadilly.—Messrs. Henney & Clarke, of 156, Sloane Street, W., are carrying out electric lighting work at 28, Aldford Street, W.—Messrs. Miller & Woods, Gray's Inn Road, Holborn, are at work in the premises of Mr. Parkinson, 50, Brook Street, W.—A contract is also being carried out by Messrs. Drake & Gorham in the premises of the Zoological Society of London, 3, Hanover Square.—Messrs. Rashleigh Phipps & Co. have secured the contract for completely installing Messrs. Duveen Bros.' new extensive premises in Old Bond Street. The same firm have also twelve other West End private houses in hand for wiring and fittings.

Calendars, Catalogues, Lists, &c.—Messrs. Geo. Skudder & Co., of Tooley Street, London Bridge, have forwarded us one of their almanacs for 1893. The almanac is a good sized one for its kind, and will be very useful in many establishments, and will be a good advertisement for the firm, as the name "Skudder" appears all over the sheets.

From the New York Equipment Company we have received some of their "Souvenir" Vest Pocket Memorandum Tablets, which are certainly very handy. They consist of a number of pieces of celluloid, fastened together at the top, one piece 2½ inches by 3¾ inches for each day in the week, on which notes may be made, and the whole thing will fit nicely into the waistcoat pocket, as well as serving as a first class advertisement for the company.

Mr. G. A. Nussbaum, of 29, Ludgate Hill, has sent us a copy of the latest (January, 1893) illustrated catalogue of telegraph appliances published by the Société Générale des Téléphones, for whom he is London agent. The book consists of nearly 200 pages of matter, (printed in French), regarding the manufactures of the company. A large number of illustrations are given. Among the various apparatus described are Morse operators, galvanometers of different types, lightning conductors, commutators, electric bells, Morse receivers, batteries, telephones, and all telegraph and telephone accessories.

Aberdeen Electric Lighting.—An experiment was made in Denburn Valley last week by Mr. McWhirter, electrician, of Glasgow, who is at present in Aberdeen superintending the electrical installation in the Palace Hotel. A connection was established between the hotel dynamo and a couple of lights near the new railway cabin. It is now suggested to light the whole of the main platform by electricity.

Hove Town Hall Electric Lighting.—The Town Commissioners of Hove have appointed Mr. Frank King, of the firm of Messrs. Morgan Williams & King, of 39, Victoria Street, Westminster, to advise them in the matter of the tenders on the electric lighting of the Town Hall.

Oxford University Electric Lighting.—The Bodleian Curators of the University of Oxford have instructed Mr. Morgan Williams, of the firm of Messrs. Morgan Williams & King, of 39, Victoria Street, Westminster, to report on the proposed electric lighting of the buildings under their control.

Notice!—The Edison & Swan United Electric Light Company, Limited, announces that the statement made in the circulars of foreign lampmakers which are now being circulated in this country, to the effect that its lamp patents are now at an end, is incorrect.

Personal.—We hear that Mr. Alfred Whalley, who is working as electrical engineer to the Telegraph Manufacturing Company of Helsby, has accepted the secretaryship of the company as well.

CITY NOTES.

Eastern Telegraph Company, Limited.

THE report and accounts of the directors for the half-year ended September, 1892, presented to the forty-first half-yearly ordinary general meeting, held at Winchester House yesterday (Thursday 26th inst.), reads as follows:—

"The directors submit the accounts and balance sheet for the six months ended September 30th, 1892. The revenue for the period amounted to £352,391 0s. 7d., from which are deducted £98,797 11s. 3d. for the ordinary expenses, and £37,636 9s. 7d. for expenditure relating to repairs and renewals of cables, &c., during the half-year. After providing £4,927 7s. 7d. for income tax, there remains a balance of £211,029 12s. 2d., to which is added £661 7s. 7d., brought from the preceding half-year, making a total available balance of £211,690 19s. 9d. From this balance there have been paid—

	£	s.	d.
Interest on debentures and debenture stock	28,274	13	3
Dividend on preference shares	20,474	2	2
Two interim dividends of 2s. 6d. per share each on ordinary shares	100,000	0	0
	£148,748	15	5

leaving a balance of £62,942 4s. 4d., which is carried forward to the next account. The revenue includes £33,431 1s. 5d dividends for the half-year upon the company's shares in the Eastern and South African, the Black Sea, the Direct Spanish and the African Direct Telegraph Companies. Since the last general meeting the Government of New Zealand has agreed that this colony shall be included in the arrangement for reduced through rates to and from certain of the Australasian colonies, and has joined with those colonies in the guarantee. The guaranteeing governments found that the reduced tariff during the first year resulted in greater loss than they anticipated, and to meet their wishes the Associated Telegraph Companies agreed to an increase of 9d. per word in the rates for ordinary telegrams. The new tariffs came into operation on the 1st instant. In December last the directors offered to the holders of the company's 5 per cent. debentures, redeemable at par in 1899, the option of exchanging their security for the 4 per cent. mortgage debenture stock of the company. The holders of the debentures have largely availed themselves of the opportunity thus given to them of acquiring this permanent security. In accordance with the provisions of the Articles of Association, two of the directors, George Garden Nicol, Esq., and John Denison Pender, Esq., retire by rotation at this meeting, and, being eligible, offer themselves for re-election. The auditors, Mr. Henry Dever, and Messrs. Welton, Jones & Co., retire, and offer themselves for re-election.

At the meeting held yesterday, the CHAIRMAN (Sir John Pender, G.C.M.G., M.P.), presided. In the course of his remarks in regard to the working, he stated that the gross revenue for the half-year under review amounted to £352,391, as against £354,939 in the corresponding period of the previous year, or a decrease of £2,548. In analysing the message receipts, they found decreases in the tariffs of certain places which were almost recouped by increases in other directions. There was no very considerable fluctuation anywhere, and the amounts received from their investments in other companies was practically the same as in the corresponding half-year. The total working expenses of the half-year to December 30th, 1892, amounted to £98,797, as against £97,131, or an increase of £1,666, the details of which were as follows: General expenses in London, £9,120, as against £9,412, a decrease of £292. Working expenses at stations, £74,486, as against £73,098; increase, £1,368. Repairs to buildings at stations were less by £1,461. On the other hand, they had written off £1,754 for depreciation of cable stocks, the result being a net increase of £1,666 in the total working expenses. Expenses attending repairs and renewals of cables amounted to £37,636, as against £47,047, a decrease of £9,411. In addition to keeping their own cables efficient, they had been doing work for the South African, West African, and the Brazilian Submarine Telegraph Companies, with which they were in friendly relation, and working very much upon co-operative principles. The amount received from those companies, together with the Eastern Company having to expend less cable on their own repairs, had the effect of reducing the expenses under that head, which had enabled them, notwithstanding the reduction of £2,548 in their receipts, to carry forward to next half-year £62,847, against £57,509, or an increase of £5,338. He thought that a very satisfactory statement, and he might say that their ships employed in repairing those other cables had earned something like £15,000 for the half-year. After making some remarks regarding the debentures mentioned in paragraph 6 of the report, he went on to talk of interruptions of the cables. He stated that that very day their land line at Cairo was interrupted by a storm. During the last month they had had many repairs to make; they had taken out 30 faults in about 10 cables, which showed that their property was well in hand, and the system adopted made the continuity of their cables so reliable, that the public rarely knew if any interruption took place. After some lengthy remarks regarding the Egyptian question, and also regarding Mr. Rhodes's projected telegraph line from Cape Town up through the interior, he said that since the last meeting they had made a contract with Her Majesty's Government in which India was interested; it was to lay a cable from Zanzibar (the company's system there) through to the Seychelles and to Mauritius. From that they got a guarantee for 20 years of £28,000 a year. It added a figure to their system, and also strengthened them by giving them a considerable sum from the Government for carrying out the work. That would be acceptable information to the shareholders, and altogether he thought they were in as strong a position to-day as ever they had been.

Sir JAMES ANDERSON having pointed out on the map the route of Mr. Rhodes's line, the motion was seconded by the MARQUIS of ALBEMARLE and carried unanimously.

At this stage the Chairman stated he had just heard that the Cairo line was again opened for traffic.

The retiring directors (Messrs. G. G. Nicol and J. D. Pender) were re-elected, also the auditors, and a vote of thanks to the chairman and directors closed the meeting.

St. James's and Pall Mall Electric Light Company.

THE annual ordinary general meeting of this company was held on Tuesday last at the company's central station, Carnaby Street, Golden Square, W., Mr. Eustace J. A. Balfour presiding.

The SECRETARY (Mr. F. J. Walker) having read the notice convening the meeting, a resolution was passed, taking the report and accounts as read.

The CHAIRMAN moved the following resolution: "That the report and accounts for the year ending December 31st, 1892, as submitted by the directors, be received and adopted, and that the dividends recommended therein be declared, and paid on February 1st." He then addressed the meeting as follows:—In moving the adoption of the report and accounts, I think that it will be of interest to the shareholders if I briefly go into a few matters in connection with the year's working, and with the present condition of the affairs of the company. We may look back upon the past year with satisfaction; there is, it is true, nothing showy or brilliant in our report, and the dividend which we recommend, although not so large as some may have ventured to anticipate, yet shows that the business possesses a most satisfactory earning power; for it must be borne in mind that in the future we have every reason to suppose that our earnings will increase without any considerable additional capital expenditure. One of the most curious features of the year is the economy which consumers now exercise, as compared with former years. This may best be shown by comparing the relative increase in the gross income from supply of lighting, and the number of lamps wired. The latter is 24·4 per cent., while the former is only 10·4 per cent. Had our gross income increased in proportion to the number of lamps wired, our net earnings would have enabled us to pay a much larger dividend. Looking, however, at this matter broadly, I think that it probably is a good feature in the business, because I think that many would-be customers have hitherto held aloof, owing to a general belief that electric lighting was extremely costly. A very satisfactory feature of the year's working is the saving effected in the cost of production. Thus the consumption of coal has been diminished by ¼ lb. per unit sold, while that of water has been reduced from 13·6 to 11·5 lbs. per pound of coal. Dealing with these figures, the editor of *Lightning* says:—"From these figures it will be seen that Mr. Crompton's 'sheer costs' estimate is more than realised. The total costs show altogether a reduction of ¼d. per unit, which cannot but be regarded as very satisfactory, and reflecting high spirit on Mr. Dobson, the company's able engineer;" a remark with which the directors cordially agree. It is our intention to maintain, and, if possible, to increase this economy. While at this subject, I think that you should realise that our economical management does not apply to cost of production alone, but also to capital expenditure. In this we compare very favourably with any other metropolitan companies. I cannot particularise, but our capital expenditure per unit of capacity is satisfactorily low. Indeed, there is one company which has spent about double what we have done, while the most favourable is considerably ahead of us. These results have only been obtained by the most rigid and continuous supervision. You will notice that there has been a considerable reduction in the amounts set aside for depreciation of plant and machinery. After careful consideration, the directors came to the conclusion that the very large expenditure for repairs, maintenance and renewals, justified this reduction, but the putting of the expenditure at a just valuation is a matter which will have to be considered in each year on its own merits, as the conditions are constantly varied. For instance, a few days ago serious damage was done to one of our engines in Mason's Yard by the breaking of the crank-shaft; we cannot be free from such accidents, which must be regarded as inseparable from the wear and tear of our delicate machinery. We regret extremely the result of the action brought against the company by Dr. John Hopkinson in respect to the "three-wire patent," and are carefully considering what form of action to take in the matter. The idea seems to have got abroad that our supply can thereby be stopped. This is not the case, as arrangements have been made by which, if necessary, the supply can be continued without further infringement of the patent. We cannot, at this time, go into further detail. On June 7th last four gentlemen, representing some of the founders' shareholders, issued a circular calling a meeting of the founders' shareholders to consider

certain matters in connection with the management of the company, which they regarded as detrimental to their interests. The directors, while, of course, they are bound to consider the interests of the whole body of shareholders only, were anxious to discuss these matters in a friendly way with the representatives of the founders' shareholders, and a meeting was consequently arranged between delegates from the two. The first point complained of is, "that the directors did not bring forward for division as profit the £15,000 received by them as premium on 10,000 shares issued in December, 1891, but intimated they had carried it over to a capital reserve account." Now, in reference to this complaint, I have to note that the directors in the prospectus under which those shares were issued stated that the amount derived from this premium would be put to capital reserve account. It was under this condition, therefore, that the shares were subscribed for. Thus the directors could not alter the arrangement if they would. Further, the owners of founders' shares who applied for shares acquiesced in this arrangement, and all had notice, but if these shares had been issued at par instead of at a premium, the founders would not have benefited. We should, in this case have issued 5 per cent. preference shares instead of 7 per cent.; but as a sum equal to 7 per cent. on the whole capital of the company has to be paid before the founders are entitled to receive any dividend, they would have been, as far as this is concerned, in exactly the same position as now, and they would not have had the contingent benefit of a quarter of this £15,000 in case of the winding up of the company. All classes of the shareholders benefit alike by the strengthening of the company, owing to the existence of the capital reserve fund. The next point raised by the representatives was that an excessive amount had been written off for depreciation. I have already dealt with the subject and can only repeat that in each year the directors will do their best to arrive at a just valuation of the amount that should be written off. They are quite at a loss to discover on what grounds the statement in this circular is made. The next objection raised is to the formation of the special redemption fund. The directors have carefully considered the representations made to them on this subject, and feel very strongly that the course they have adopted is not only right in itself but will meet with the approval of the shareholders generally. It would, no doubt, be very pleasant to divide the £2,000 which the fund now amounts to, as profits, but it would not be sound finance under the Electric Lighting Acts, and probably may be, and probably is, a vanishing security. In many ways it resembles an investment in leasehold property. We therefore feel bound to create this fund. In all these matters the directors have considered the well-being of the company as a whole and not the special interests of any class of shareholders. Then it is worth noting that in the direction of big profits the interests of the founders and ordinary shareholders are identical, since for every £1 given to a founder's shareholder a corresponding £1 is divided amongst the ordinary shareholders. I have already kept you long enough, and our arrangements here are somewhat prohibitive, but we thought you would prefer to come to this building as it is, although it is not yet finished, and see for yourselves what we have been doing here." He concluded his remarks by moving the adoption of the report.

The motion was seconded by Mr. LATIMER CLARK, F.R.S.

Mr. FRY (shareholder) thought that in the remarks the chairman had made about the founders' shareholders, he had not quite completed the story; might he therefore ask him to do so by reading the last two letters between the founders' shareholders committee and the company's solicitors. He also wished to know whether any steps had been taken to ensure a *verbatim* report of the meeting being sent out to every shareholder. The question was raised at the last meeting. He considered their electric lighting company, if not *the* best, certainly one of the best. Referring further to the founders' shareholders' question, he thought if the chairman had completed the story it would have altered the complexion of the statements he had made. Turning to the report, he thought the shareholders must feel a certain amount of disappointment that they had not been enabled to get on with this (Carnaby Street) station faster than they had. Of course, circumstances might have arisen, as the chairman said, ancient lights and other matters, but it would be much more satisfactory to the shareholders if the station had been open and earning a revenue for the last few months of the year, because they had been paying interest on capital entirely unproductive. In the question of the redemption fund, they must be aware that there were such things as rights of the founders' shareholders. Those rights were clearly pointed out in their memorandum of association, and in the articles of association, and the paragraph there distinctly stated, "without prejudice to the rights of the shareholders." The founders' shareholders' had taken the opinion of eminent counsel on the matter. They meant to contest those rights. But there was another point: they also, as ordinary shareholders, had rights which were bound up in the founders' shareholders, and if they took into consideration the clause of the Electric Lighting Act, by which powers are given to buy up the concern at the end of the time, it would be clear to anybody that they were not likely to be bought up for old iron, as it seemed to be the opinion of the directors; but, at the same time, if they were to fight their founders' shareholders, why were they to spend all the money in opposition in the Law Courts? Was it not possible in some way for the directors to alter their opinions at the last moment? If they had definitely fixed up their minds, he would have to move an amendment to the report; but he did not wish to directly oppose them unless it was absolutely necessary. After some further lengthy remarks, he referred to the three-wire case which had been lost in favour of Dr. Hopkinson. He would like to ask how it was, by whose advice and opinion, they adopted that three-wire patent, because he presumed that it was possible to find out what are patents and what are not patents, and he would like a categorical answer as to who advised them to adopt the system which had ended, it appeared, so disastrously for the company?

Colonel FRANCIS spoke regarding the question of the rate of depreciation.

Mr. SAMS having made a few remarks,

Mr. FOSTER stated that a committee of holders of founders' shares applied to the directors to refer the question to arbitration as to righting the articles of association. They even offered to accept as arbitrator the gentleman originally retained by the company, but in a letter dated January 16th, 1893, the directors refused to entertain that proposal. He would like to know whether the question was to be referred to arbitration?

The CHAIRMAN, in answering the various questions, first read the letter received by the company from the founders' shareholders committee, and Mr. MORSE (the solicitor to the company) read the reply that had been sent thereto.

The CHAIRMAN said they were always anxious to meet shareholders in the best possible way, and if the meeting finally decided by resolution, put and carried, that that matter ought to go to arbitration, then, of course, the directors would be bound by that decision. They could not say more than that. Mr. Fry had raised a point as to a *verbatim* report to be sent to the shareholders; the directors had considered this, but did not see any special reason why it was necessary. It was considerably expensive, but if it was the wish of the meeting, it should be done. The next question was the incompleteness of the station. They had already referred to that in the report, and if Mr. Fry had been inside the board meetings instead of outside when there had been hours and hours of most minute consideration, going into questions with care to avoid litigation regarding ancient lights, he would have understood the matter. The next matter was the question of the purchase of the concern by the end of 42 years. That was a very complicated question which they had thought over very carefully. He did not know any very definite legal opinions, but they had constantly discussed with their legal advisers, and it was more than likely if the local authority did buy them up at the end of their provisional order—and they have a perfect right to do so—nothing will be paid for goodwill, and all the price they would get, as Mr. Fry said, would be the price of old iron. We have got to face the fact. There was a view that the local authority might buy them up or not. He mentioned these matters to show that there were two sides to all the questions. They had carefully considered them, and, to them, two sides was not a sign of weakness but a sign of strength. Mr. Fry had asked by whose advice the three-wire system was adopted which involved the patent? Their view at the time was that it *did not* involve the patent; it was the view of almost every scientific man at this time. Colonel Francis was chairman at that time. It was discussed, and they came to the best decision they could; it had turned out to be wrong, but there were a great many scientific men who still held that they had not infringed the patent.

A rather heated conversation here took place between Colonel FRANCIS, the CHAIRMAN, and Mr. LATIMER CLARK.

In the course of further remarks,

The CHAIRMAN stated that Mr. Cottrill had sent in two questions; the first was how far the economy realised in the past year on the whole capital expenditure generally was due to the light supplied under the three-wire system. They did not admit economy in either one or the other, but they were under the belief that they could have a similar system which would have avoided the patent altogether. He did not think it wise or desirable to go into details on these questions of Mr. Cottrill's, because they would possibly have most intricate negotiations on the subject before them, and he did not think that any particulars in the present position of their machinery should be made public. Although the apparent actual defendants in the case were the St. James's Company, it was really all the electric light companies using the low tension system who were connected with it. It was their opinion altogether, and was being fought at the cost of them all.

Mr. FRY asked what they anticipated they would have to pay?

The CHAIRMAN said he had no anticipation.

Mr. COTTRILL made some further remarks regarding the "three-wire system," but

The CHAIRMAN, although he would have liked in some ways to answer him, thought it undesirable, as the information might go to the other side. Having answered Colonel Francis's question *re* depreciation,

The CHAIRMAN put the resolution to the meeting, and it was carried by 31 votes to 7.

It was stated that the board had decided to send a report of the proceedings to the shareholders.

The retiring directors, Messrs. Gerald W. Balfour, M.P., and Sir John H. Morris, were unanimously re-elected.

Col. FRANCIS moved "that the question between the founders and the directors, with regard to the redemption fund, should be submitted to arbitration."

Mr. FOSTER seconded this.

Dr. WEBB moved an amendment "that this subject be left with our trusted guardians, the directors of the company."

Mr. BOURN seconded this, and the amendment was carried by a large majority.

The auditors, Messrs. Deloitte, Dever, Griffiths & Co., were re-elected at the remuneration of 75 guineas.

A vote of thanks to the chairman and directors concluded the proceedings.

City and South London Railway Company.

THE report of the directors for the half-year ending December 31st, 1892, to be submitted to the half-yearly ordinary general meeting of the company, to be held at Winchester House, Old Broad Street, on Wednesday, February 1st, at 3 p.m., reads as follows:—The receipts

from all sources for the past half-year have amounted to £22,652 13s. 11d., and the cost of working has been £15,389 17s. 2d., leaving a profit of £7,262 16s. 9d. Inclusive of the balance brought forward from June 30th last, the net revenue account shows an aggregate total of £8,304 12s. 2d. After making provision for the debenture and debenture stock interest, amounting to £4,258 19s. 2d., a balance remains available for dividend of £4,045 13s. 0d. Out of this sum your directors recommend the full dividend of 5 per cent. per annum be paid on the preference shares, and that a dividend at the rate of $\frac{5}{8}$ per cent. per annum be paid upon the consolidated ordinary stock, leaving a balance of £822 to be carried forward to the next account. The number of passengers conveyed during the six months ended December 31st, 1892, exclusive of season ticket holders, was 3,217,602, showing an increase over the corresponding period of the previous year of 468,547. Your directors have satisfaction in reporting that the service of trains has been carried on during the whole of the half-year with great regularity, and with an almost entire absence of any interruptions whatever, whilst the receipts from traffic have increased considerably. The following table shows the number of passengers, exclusive of season ticket holders, carried since the opening of the railway in each half-year:—

Half-year ended	Number of Passengers.	Receipts (including Season Tickets). £ s. d.
December 31st, 1890 (11 days) about	165,000	1,568 3 9
June 30th, 1891	2,412,343	19,403 6 9
December 31st, 1891	2,749,055	19,798 16 6
June 30th, 1892	2,813,162	20,931 4 2
December 31st, 1892	3,217,602	22,002 17 5
Total since the opening of the line	11,357,162	£83,704 8 7

By the certificate of the engineer, it will be seen that the locomotives, rolling stock, and generating plant have been efficiently maintained and are in good working order. Difficulties with the local authorities have delayed the commencement of the much needed siding accommodation at Stockwell Station, forming part of the Clapham Extension Line, but it is hoped that these works will very shortly be started. The conversion of the terminal debentures into either 4 per cent. perpetual debenture stock, or 5 per cent. perpetual preference shares is progressing satisfactorily, and will result in a considerable saving of interest to the company. A resolution for the conversion into consolidated ordinary stock of the remaining 3,000 ordinary shares already issued, will be submitted to the special meeting, to be held at the conclusion of the half-yearly meeting. It is anticipated that the bill promoted in the last parliament by this company for the extension to Islington and other purposes, will be proceeded with immediately after parliament assembles. A bill to extend the time for the purchase of lands under the Act of 1890 (Clapham Extension), and for other purposes, has been deposited in parliament for this session. The directors retiring by rotation are Messrs. Charles Seymour Grenfell and Edwin Tate, who are eligible for re-election. The auditors retiring are Messrs. Turquand, Youngs, Weise, Bishop & Clarke, and they offer themselves for re-election.

Newcastle-upon-Tyne Electric Supply Company, Limited.

THE directors' report reads as follows:—"The directors have pleasure in presenting the balance-sheet and profit and loss account for the year ending December 31st, 1892. The amount of share capital subscribed amounts to £29,920, on which £25,699 has been paid. Besides this, £15,000 has been raised on debentures. The profit and loss account shows a gross profit of £2,300 5s. 1d., which is reduced to £1,311 19s., by payment of £988 6s. 1d. for interest on debentures and on calls in advance. This, added to the amount brought forward, viz., £364 13s. 3d., makes a total of £1,676 12s. 3d. to be disposed of. Out of this sum the directors propose the payment of a dividend at the rate of 4 per cent. per annum, less income tax, payable on February 1st, which, on the capital as paid during 1892, will absorb £895 13s. 5d., leaving a balance to be carried forward of £780 18s. 10d. Out of this amount the directors recommend that a sum of £600 be carried to a reserve fund, to meet any depreciation that may arise on the company's assets. The retiring directors are Mr. James Tennant and Dr. R. S. Watson, who offer themselves for re-election. The auditor, Mr. Thos. Harrison, also retires."

BALANCE-SHEET, December 31st, 1892.

LIABILITIES.

	£	s.	d.
Nominal Capital—10,000 shares of £5 each	50,000	0	0
Issued and Allotted—5,984 shares of £4 per share called up, £23,936; add calls paid in advance, £1,763	25,699	0	0
Six pet cent, mortgage debentures	15,000	0	0
Creditors—On sundry accounts, £2,175 14s. 4d.; bank overdraft, £510 5s. 4d.	2,685	19	8
Profit and Loss Account—As at December 31st, 1891, £1,006 8s. 7d.; less dividend at 4 per cent. per annum, for year ending December 31st, 1891, £641 15s. 4d.; add profit for year to date, £1,311 19s. ...	1,676	12	3
	£45,061	11	11

ASSETS.

	£	s.	d.
Capital Expenditure—Buildings and Plant—As at December 31st, 1891, £29,427 5s. 2d.; Additions to date, £4,894 16s. 8d.	34,322	1	10
Meters, Transformers, &c.—As at December 31st, 1891, £4,159 17s. 1d.; additions to date, £1,122 6s. 6d.	5,282	3	7
	39,604	5	5
Loose Plant and Tools—As at December 31st, 1891, £294 19s. 6d.; additions to date, £74 0s. 5d. ...	368	19	11
Office Furniture—As at December 31st, 1891, £104 15s. 8d.; additions to date £1 15s.	106	10	0
Preliminary and Formation Expenses—As at December, 1891, £654 3s. 8d.; further expenditure to date, £172 6s. 0d.	826	9	8
Stocks and Work in Progress	1,728	9	4
Debtors—On current supply, £1,419 2s. 5d; sundry debtors, £918 4s. 8d....	2,337	7	1
Cash in hand	89	9	10
	£45,061	11	11

THE PROFIT AND LOSS ACCOUNT for the year ending December 31st, 1892.

Dr.	£	s.	d.
To Station charges—Salaries, wages, coal, water and maintenance	2,789	10	8
„ Street charges—Salaries and maintenance	492	0	6
„ Rent, rates, taxes and insurance	280	13	11
„ General charges—Directors' remuneration, £131 5s.; office salaries, legal and accountancy charges, stationery, stamps, telegrams, &c., £218 16s. 4d. ...	350	1	4
„ Balance carried down	2,300	5	1
	£6,212	11	6

	£	s.	d.
To Interest—On debentures, £907 0s. 6d.; on calls paid in advance, £81 5s. 7d.	988	6	1
„ Balance carried down	1,311	19	0
	£2,300	5	1

Cr.	£	s.	d.
By Current supply, £5,606 14s. 2d.; public lamp supply, £56 2s.	5,662	16	2
„ Apparatus rent	525	6	4
„ Profit on sale of lamps	22	15	6
„ Transfer fees	1	13	6
	£6,212	11	6

	£	s.	d.
By Balance brought down, being gross profit for year ...	2,300	5	1
	£2,300	5	1

	£	s.	d.
„ Balance, being profit for year	1,311	19	0

The fifth general meeting of the above company was held on 19th inst. at the Central Station Hotel. The directors' report and the balance-sheet having been adopted, a dividend of 4 per cent. was declared for the year ending December 31st, 1892.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending January 22nd, 1893, amounted to £973; week ending January 24th, 1892, £811; increase £162; total receipts for half-year, 1893, £2,978; corresponding period, 1892, £2,505; increase £473.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending January 20th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company Limited, were £3,653.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Issue.	Name.	Stock or Share.	Closing Quotation January 19th.	Closing Quotation, January 26th.	Business done during week ended January 26th, 1893. Highest.	Lowest.
195,100*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	100 —103	100 — 103	...	...
1,247,720*l*	Anglo-American Telegraph, Limited	Stock	53½— 54½	54¼— 55⅛	55	53⅜
2,876,140*l*	Do. do. 6 p. c. Preferred	Stock	96½— 97½	96½— 97½	97⅜	96½
2,876,140*l*	Do. do. Deferred	Stock	12¼— 12⅜	13⅛— 13⅜	13⅜	12⅞
130,000	Brazilian Submarine Telegraph, Limited	10	11 — 11½	11 — 11½	11½	11¼
34,600*l*	Do. do. 5 p. c. Bonds	100	101 —104	101⅜—104	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	104 —108	104 —118	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	3⅛— 3⅜	3⅛— 3⅜	3⅜	3⅛
75,000	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2⅛— 2⅛	2⅜— 2⅜	2 9/16	2⅜
125,000*l*	Do. do. 4½ per cent. Debenture Stock	Stock	101 —103	103 —105	103⅝	102¼
40,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	3 — 4	3 — 4	...	...
600,000*l*	City and South London Railway	Stock	35 — 38	35 — 38	...	...
40,000	City of London Elec. Lighting Co., Ltd., Ord. 40,001-80,000 ...	10	11¼— 12	11⅜— 12¼	11 11/16	11⅜
20,000	Do. do. 6 p. c. Cum. Pref., Nos. 1 to 20,000	10	7⅞— 8¼	7⅞— 8¼	8⅛	7⅞
$7,716,000	Commercial Cable, Capital Stock	$100	175 —180	175 — 180	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ..	14/-	3/16— 5/16	3/16— 5/16	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	5 — 5½	5 — 5½	...	...
16,000	Cuba Telegraph, Limited	10	12 — 13	12 — 13	12½	12
6,000	Do. do. 10 p. c. Preference	10	17½ — 18½	17½ — 18½	17⅞	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	2 — 3	2 — 3	...	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	...	...
60,710	Direct United States Cable, Limited, 1877	20	11⅛ — 11⅝	11⅝ — 12	12	11 13/16
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅝— 14⅞xd	14⅝— 15	14 15/16	14 11/16
70,000	Do. 6 p. c. Preference	10	16 — 17 xd	16 — 17	16⅞	16¼
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	107 —110	108 —111	...	...
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	110 —113	111 —114	113	111½
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	14⅜— 15 xd	14⅞— 15⅛	15 1/16	14⅜
70,600*l*	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	102 —105	1 2 —105	...	...
250,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	102 —105	102 —105	...	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	111 —114	111 —114	...	...
122,400*l*	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	101 —104	102 —105	...	...
163,700*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	101 —104	102 —105	...	...
300,000*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	103 —106	103 —106	...	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	2¼ - 2⅜	2¼ - 2⅜	2 5/16	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
100,000	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	1 1/16— 1 3/16	1/8 - 1/4	...	...
82,395	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	3/32— 1/8	1/8 - 5/32	...	...
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	3/32— 1/8	3/32— 1/8	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	9⅜ - 10	9⅜ - 10	10	9⅝
180,042	Do. do. 6 p. c. Preference	10	15 — 15¼xd	15 — 15¼	15¼	15
150,000	Great Northern Tel. Company of Copenhagen	10	18⅞ - 19¼	18⅞— 19¼	18¼	...
210,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	105 —108	105 —108	106¼	...
12,134*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	4½ — 5½	4½— 5½	4	...
9,600*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	8 — 9	8 — 9	...	...
50,000	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	21½ — 22½	22 — 23	22⅞	22
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	102 —104	102 —104	...	...
17,000	Indo-European Telegraph, Limited	25	44 — 46	44 — 46	44	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	2½— 3½	2½— 3½	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	6 — 7	6 — 7	...	...
30,000	†Liverpool Electric Supply, £3 10s. paid	5	3⅜— 4	3⅜ — 3⅝	4⅛	3⅞
10,000	Do. do. fully paid	5	5½— 5⅝	5¼ — 5⅜	5⅜	5¼
38,348	London Platino-Brazilian Telegraph, Limited	10	4 — 6	4 — 6	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	108 —111	108 —111	...	...
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	6⅜— 7¼	6⅜— 7¼	7	6⅝
50,000*l*	Do. 5 p.c. debentures, 1 to 5,000 in bonds of £10, £20, £40	...	102 —105	102 —105	...	...
454,747	National Telephone, Limited, Nos. 1. to 438,984	5	4⅜— 5	4⅜— 5⅛	5⅛	4⅞
15,000	Do. 6 p. c. Cum., 1st Preference	10	14 — 15	14 — 15	...	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	13⅜— 14¼	13⅜— 14¼	13⅞	...
90,950	Do. 5 p. c. Non-cum. 3rd Pref., Nos. 1 to 90,950 ...	5	4¼— 4⅜	4¼— 4⅜	4⅜	4 7/16
726,477*l*	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	112 —115	112 —115	114	113
48,800*l*	New Telephone, Limited, Nos. 25,901 to 74,700 ... (£2 paid)	10	... ...	... ...	...	...
6,318	Notting Hill Electric Lighting Company, Limited, fully paid ...	10	5 — 6	5 — 6	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	1/16— 1/16	1/8 — 1/4	...	...
11,802	Reuter's Limited	8	7½ — 8½	7½— 8½	...	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	7½— 8	7⅜— 8⅛	8	7⅞
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	8⅛— 8⅜	8⅛— 8⅜	8 1/16	8 1/16
3,381	Submarine Cables Trust	Cert.	117 —122	120 —125	121⅛	120¾
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	3 — 3½	3 — 3½	3⅜	...
37,350	Telegraph Construction and Maintenance, Limited	12	45 — 47	45 — 47	46¾	46
150,000*l*	Do do. do. 5 p. c. Bonds, red. 1894	100	101 —104	101 —104	...	...
58,000	United River Plate Telephone, Limited	5	2½ - 3	2½ — 3	...	...
146,370*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	90 —100 xd	90 — 100	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	6½ — 7½	6½ — 7½	...	...
260,900*l*	Do. do. do. 5 p. c. Debentures	100	101 —104	101 —104	...	...
30,000	West Coast of America Telegraph, Limited	10	2½ - 3½	2½ - 3½	...	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	101 —105	101 —105	...	...
64,242	Western and Brazilian Telegraph, Limited	15	7⅞ - 8⅛	7⅞— 8⅛	8⅛	7 13/16
33,129	Do. do. do. 5 p. c. Cum. Preferred	7½	5¾ - 6¼	5¾ - 6¼	6	...
33,129	Do. do. do. 5 p. c. Deferred	7½	1¾ - 2¼	1¾ - 2¼	...	...
184,100*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	106 —109	107 —110	...	...
230,100*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	106 —109	107 —110	109	...
88,321	West India and Panama Telegraph, Limited	10	1⅜ - 1⅝	1½ — 1⅝	1⅝	1½
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	10¼ - 10⅜	10¼— 11	11	10½
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	8½ - 9½	8½ — 9½	9 7/16	9
80,000*l*	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	105 —108	105 —108	...	...
$1,536,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	120 —125	120 —125	...	...
175,000*l*	Do. do. 6 p. c. Sterling Bonds	100	100 —103	103 —106	105⅛	105¼
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	5½— 6	5⅝ — 6¼	6	5⅞

* Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange. Bank rate of discount, 2½ per cent. (January 26th, 1893.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Blackpool Electric Tramway Company, Limited, £10 (£5½ paid), 7⅛—7⅜.—Brush Company 4½ per cent. Debenture stock, issued at 1 per cent. premium, 100—103.—Electric and General Investment, shares of £5 (£1 paid), 1¾—2¼xd.—Founders' shares, 200—225.—Electric Construction Corporation, 6 per cent. Debentures, 95—98.—Electricity Supply Corporation, Ordinary of £5, 5—5¼.—Elmore Foreign and Colonial Copper, Founders shares, 6⅛—7⅛.—European Sims-Edison Torpedo Company, shares £20 (fully paid), 20—20¼.—Founders' shares, 10—20.—Halifax and Bermuda Cable 4½ per cent. bonds 80—90.—House to House Company (£5 paid) 1¼—2¼.—Do. 7 per cent. Preference of £5, 5—5¼.—Do. 6 per cent. Debentures of £100, 97—102.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 5—5¼, 1st Preference Cumulative 6 per cent., £5 (fully paid), 6—6¼.—Liverpool Electric Supply Shares of £5 (fully paid), 5⅛—5⅜.—Manchester, Edison and Swan Company, £9 (£1 paid), ⅛—¼.—Queen Anne's Mansions Lighting and Heating, Debentures, 101—103.—Woodhouse and Rawson £5 Preference (fully paid), ¾—1¼.

THE MANUFACTURE OF THE VOLTA INCANDESCENCE LAMPS.*

DURING a recent visit to Brussels an opportunity was afforded us of inspecting a very interesting manufacture of incandescence lamps at Schærbecklès-Bruxelles. These works supply the Volta lamp now very generally used in France. An old four-storied steam mill has been adapted for this new industry under conditions, the description of which will certainly interest our readers.

Two Galloway boilers supply steam to a horizontal 120 H.P. engine of the Walschærts type. This motor turns at a speed of 54 revolutions, and its fly-wheel sets in motion a general system of transmission working the whole of the machinery, viz. :—

Two Schuckert dynamos of 120 volts, and 200 to 250 ampères at speeds of 600 and 700 revolutions. One of these machines serves to light the works and the other to feed the lamps placed on the mercury pumps, of which we shall speak presently.

Another Schuckert dynamo of 350 volts, 10 ampères for the preparation of the filaments. A third Schuckert dynamo of 180 volts, 10 ampères, for photometric experiments.

The same transmission works a water pump for the use of the works, a ventilator for the glass-blowing room, an air pump for producing the *first vacuum* and, lastly, a pressure pump constructed by Wesse and Monski, of Halle, working over a reservoir registered at 8 kg. per cm. for working the 50 mercury pumps on the first floor. With this plant the Schærbeck works can turn out 2,000 lamps per day.

The most interesting part of the whole of the works is no doubt the manufacture of the artificial filament, substituted by the company for the *piazzava* filament employed previously. These processes, however, are a secret, and we cannot abuse the confidence placed in us by the manager in initiating us into all the details of the manufacture. We will simply say that this slender filament, which seems quite insignificant in the finished lamp, requires most careful preparation from beginning to end. It passes through baths and washings innumerable, from alcohol at 98 or 100° to pure water, and is at last turned out in skeins similar to a bundle of yellowish white horsehair. Even when manufactured most carefully, the waste is very great, for the thickness of these filaments is determined most carefully. They are tested throughout their length by a micrograph graduated in hundredths of a millimetre, and the young employé to whom this testing is entrusted has a reward for every irregularity proved. Moreover, a most completely fitted laboratory is annexed to this first department, and here every kind of instrument for electric or photometric measurement is to be found. The filament when manufactured is somewhat damp, it has, therefore, to undergo various operations and drying processes before being carbonised. It is first cut to the lengths required, then formed into a loop on a moulding board, then immediately subjected to an electric heating *in vacuo* by means of a very ingenious little ampèremeter which interrupts the current automatically as soon as it attains the necessary intensity for the degree of carbonisation required, which is determined before the operation by means of a regulating screw. Simultaneously with this operation the little platinum wires intended to support the filaments are cut and prepared. This process entails a certain amount of confidence, for the coil of platinum wire entrusted to the workwoman is worth from 500 to 600 francs., this metal being sold at 1,200 to 1,300 francs the kilogramme. As the lengths of platinum are cut, a boy flattens out the ends into a spoon shape in which the filament rests ; then the pieces of platinum are connected two and two by a glass bridge. Women then fasten the two extremities of the filament to the pieces of platinum by means of a special cement, and the whole is then subjected to the heating process. This operation is performed by four young girls, three of whom are occupied in carbonising the filaments, and the fourth distributes the current to the others as they require it, for, of course, before this carbonising is effected, it is necessary to have a perfect vacuum in the bell glass which serves as the furnace. On this work depends the quality of the lamps, for not a single defective filament must be allowed to pass.

The mineral filament of the Volta lamp, when carbonised, is grey. The whole, including the platinum, must have a uniform length, so as to be enclosed in the glass bulb; I found with a certain degree of pleasure that, the Belgian glassworks cannot produce such pretty bulbs as our French ones, and I once more regretted that works for the manufacture of incandescence lamps should not be established in our French mountains, the Cevennes or Alps, where women and young girls are accustomed to the delicate operations of the silk manufacture. There are powerful waterfalls of 100 to 200 H.P. which might be utilised for this purpose.

The glass-blowing room is exclusively in the charge of men. Some attach to the bulb a little glass tube through which the perfect vacuum is to be made. Others place the filament in the bulbs thus prepared, and then close the lamp by impressing on the glass little cavities in which the plaster is to adhere. The extremity of the platinum wires is then bent into eyes and the lamp is then sent to the third floor for the vacuum to be made. In this room, on the third floor, are grouped 50 mercury pumps. About 25,000 francs worth of this metal is constantly being sent through labyrinths of glass tubes to arrive, after a certain number of operations, at the total suppression of every particle of oxygen or other gas, which is evaporated from the filament as its temperature is raised. Each lamp, furnished with its little glass tube, is then soldered on to a bridge with several branches, and this bridge is then subjected to the exhausting process. This work is most important ; on the perfection of the vacuum in the bulb will depend the duration and consumption of the lamp, by not allowing the filament to become blackened, and enabling it to keep a constant luminous intensity.

Another delicate operation is the detaching of the finished lamps from these bridges. To do this the tube is cut by means of a gas jet, and then formed into that point which is to be seen at the head of all incandescence lamps. Little Ruhmkorff coils are arranged on all sides for testing the vacuum.

The lamp is then tested from the point of view of voltage and the number of candles. It will easily be understood that it is practically impossible to make all the filaments intended, for instance, for 65 volt lamps, absolutely homogeneous. Therefore, all the lamps are tried *one by one* at the laboratory. Young girls are entrusted with this task. We find here instruments of great precision, a galvanoscope, a true voltmeter, a torsion galvanometer, a photometer, a standard candle, &c. A lamp is first established as a type at the voltage required by means of a standard candle. Then, by means of a photometric rule, 3 metres long, all the lamps of the same luminous power are tried, the number of volts necessary to attain the required intensity in candles being carefully noted. It is evident that all the lamps requiring 62, 63, 64, 66, or 67 volts are all classed with the 65-volt lamp, which is the type in general use. If manufacturers thought to vary each year the speed and the excitation of their dynamos, giving them a few turns more or less, they would probably obtain from lamp manufacturers lamps absolutely reliable.

The lamps thus tested are marked with a trade sign which will enable the manufacturer to determine the exact date of its issue. This is also done in the central works which supply their consumers with lamps themselves. The lamp has now only to be supplied with its socket, which is only done when it is ordered, as there are so many patterns in use. Two of these, however, seem likely to become general ; the bayonet socket and the screw socket. The eyes are then soldered to little brass wires, and placed in the socket by means of plaster. This work is also done by women. Footlights, containing 50 sockets of each type, serve to test all the lamps finally before packing. An ampèremeter with a large dial and a voltmeter, allow it to be seen at once whether the burning of these lamps is normal. The lamp is then labelled and is ready to be delivered. Each lamp when sent out is enclosed in a sheet of fluted cardboard which thus forms a kind of padding, which would allow the lamp to fall even on the pavement without being broken.

All these different operations (the lamp passes through

* *L'Industrie Electrique.*

121 different hands before leaving the works) require the strictest supervision. The master's eye is needed every instant. Thus every morning the foremen place before the manager a paper containing full details of the work of the day before, the material received in, the work sent out, the articles rejected, and this last point is very important to a manufacturer careful of his reputation. I was neither announced nor expected, and I saw that *no* lamp was sent out without being most rigorously tested by the standards. But what care and attention must be bestowed upon work of this kind in order to be able to send out lamps at the low prices to which they have now fallen! It is evident that the palm will be awarded to the most scrupulous manufacturer who will accustom his staff to put aside unfailingly every defective lamp, so as to offer to the public a product of irreproachable quality under the best conditions.

LOCATING TROUBLE ON ARC AND POWER CIRCUITS IN CENTRAL STATION WORK.*

BY C. O. POOLE.

As the title of this paper indicates, its object is to deal with the process of locating trouble on overhead construction in arc and power transmissions, rather than to suggest remedies or attempt to improve the line work.

There is an old saying that "if a fellow looks for trouble he is sure to find it very quick." While this may be true when said of a man armed with a club looking for his neighbour's dog, it does not hold good when applied to a lineman armed with a pair of spurs and magneto bell, looking for an open circuit, or a short circuit, or a ground, or a cross, as the case may be. And it is by no means a pleasant undertaking, when the customers, whose lights are not burning, are making the telephone wires hot, and the superintendent's heart sad with these questions and complaints: "What is the matter with our light?" "Will it be going soon?" "Is anybody else's light out?" "Is this likely to occur again?" "What is the reason it don't burn?" "I have tried the broom handle and it don't do any good, there must be something the matter with the lamp; send a man down to repair it." The superintendent will have to reply to this torrent of questions, with all the suavity at his command, and present explanations and apologies sufficient to satisfy any man other than one whose place of business has been left in darkness for several hours because the linemen with their spurs and magneto bell and hampered with rubber coats and gum boots, had been unable to find the cause of the annoyance on a circuit 15 to 20 miles long, and consequently those 50 or 60 lights, if 9.30 lights, did not burn that night; or if 12 o'clock or all night lights they did not burn until late in the night.

It is of such cases as these, which are by no means uncommon, that I wish to speak. I am aware that many means have been employed for testing purposes; but most of them have been too complicated, or too expensive, or unreliable, or for some other cause have been discarded, and the old reliable magneto bell looms up in all its greatness.

When the lineman is sent out on a circuit to find trouble, he knows three things: First, the circuit he has to go out on; second, that there is a ground, a cross, a short circuit or an open circuit; and last, but not least, that if he does not find it in short order he will hear from the superintendent.

If it be an open circuit and he has the advantage of working in daylight, the first thing he does is to ground both legs of the circuit of the switchboard in the station, then with an assistant, go to the first convenient lamp on the circuit, open the circuit at the lamp, ground one side of his magneto bell, and test both ways towards the grounded ends in the station. Suppose he is working at the first lamp on the positive leg, he tests that wire back to the station and fails to get a ring; he knows then that the open circuit is between the station and where he has made the test. He then traces the circuit back toward the station, until he finds the break. If, however, he should get a ring when he tests the positive wire toward the station, he then tests the other end of the wire, and, finding it open, continues his search in that direction, until he passes the break and gets a ring on the negative leg; he then knows, of course, that the point lies between the last place of testing, and his present position. If a circuit should open at night during the run, the following method is sometimes used to advantage:—The lineman instructs the dynamo tender to leave the machine on the circuit; he then arms himself with a pair of spurs and a short piece of wire, and for once the magneto bell is not in it. His knowledge of the circuit enables him to soon reach a pole where both legs of the circuit are on the same cross-arm. Buckling his spurs on he quickly mounts the pole, and baring the circuit wires, brings into service the short piece of wire before mentioned, with which he strikes both of the circuit wires. If a flash is the result, he knows that he has to go further out on the circuit. After climbing another pole some distance further on, and going through the same process of striking the wires, and failing to get a flash, he concludes, of course, the trouble lies between the first and second test. As soon as the broken ends are reached and spliced together, the lights immediately start up. That is one advantage of having the machine on the circuit, while there is the disadvantage of working with the machine that is liable to jump at you with about two or three thousand volts, which is by no means a pleasant thing to handle on a wet night.

In order to overcome this danger, and to allow the linemen to become a little more sociable with the circuit he is working on, the company I am with has had constructed a machine to put on this circuit, instead of the regular arc machine; the boys call it the "jigger." It is simply a combined motor and dynamo connected together on the same shaft. It is placed on a roller platform, and stands in the corner of the station until wanted. The motor is wound for 10 ampères, constant current, and has a capacity of about 2 H.P. The dynamo is wound for constant potential, with an output of about 15 ampères at 200 to 300 volts. When required, the motor part is connected in the arc circuit and is run up to speed. The dynamo terminals are connected to a suitable plug, and a plug put in the circuit that is open. You will readily understand, if the wires be short-circuited as before mentioned, a current will immediately be generated and a flash will be the result.

Not knowing of any better methods than the ones above described for locating a break in the open circuit, I cannot offer any suggestions that would be of benefit. Of course, if the wire should break, and one or both ends fall to the earth, and make a fairly good ground, you would, by means of the Wheatstone bridge and galvanometer, be able to make an intelligent guess, that is all. There are so many doubtful points to be considered in measuring lamp circuits that it makes a calculation almost worthless. For instance, if you had to depend upon the path through the carbons of a lamp, the resistance may be a fraction of an ohm, or it may be 10 ohms. Again, if the carbon be burned out in a lamp that depends upon the current to keep the cut-out in contact, then you would have to deal with the resistance of the shunt winding, which would amount to 200 or 300 ohms.

Another element of uncertainty that might be mentioned is that of induction. I remember one case in particular. After personally going over all the lamps on the circuit, which was about 15 miles long and consisted of No. 6 B. & S. wire, I attempted to measure it with the bridge and galvanometer. I found it impossible to get a satisfactory reading. One instant 30 or 40 ohms would almost balance, and the next instant it would take 400 or 500 ohms to bring the needle to anything near a standstill, while in the next instant it would be found down at zero, with the negative sign before it. The bridge was one of the best, and the galvanometer a Thomson reflecting instrument; both having been previously tested and found correct. The only way that I could account for the phenomena was in the fact that for some distance the lines ran parallel on the same pole with a live circuit. So, everything considered, in my opinion the bridge and galvanometer is not a satisfactory method of testing lamp circuits. I will say, however, in this connection that in some few cases, by the use of the bridge, I have determined the position of grounds and short circuits on trunk lines, and on circuits where the trouble occurred between the station and the first or last lamp.

* Read before the California Electrical Society, San Francisco, December 18th, 1892.

In instances of this kind, the uncertainty of lamp measurements need not be taken into consideration, and the question resolves itself simply into a matter of measurements and calculations. As an example, suppose the trunk line of No. 6 B. & S. wire be 2 miles long, and the wire becomes short-circuited at an unknown distance from the station. If on measuring it you find the resistance to be 4·176 ohms, and upon referring to a table of resistances you find the resistance of 1 mile of No. 6 wire to be 2·088 ohms; dividing 4·176, the measured resistance of the circuit, by the resistance per mile of wire 2·088, the result will be 2; meaning, of course, that the wire measured was two miles long, and the circuit consisting of two wires, would make the distance from the station to the point of trouble just one mile. If the short circuit had been caused by two grounds, their position could have been determined by the same process as just described; the only difference being to connect one post of the bridge to one side of the line and the other to ground. Then if you found a resistance of 2·088 ohms, and considering the ground resistance to be *nil*, you would know at once that the ground on that side of the circuit would be one mile from the station; assuming, of course, that the measurements be made in the station. After getting your distance, and telling the linemen where to find the trouble, it is a matter of but a few minutes until the circuit is clear, and there is light once more. Now, if the linemen had not been told where to find the trouble, and simply to go out and find the short circuit, it would have been necessary to trace the wires from the station until the place of trouble was reached; or by taking the magneto he could have cut the wires and tested both ways. This might have to be repeated several times; and aside from the disadvantage of having a full line of splices, would have taken much longer to locate the trouble.

We have seen how an open circuit and a short circuit are located. Now let us follow the linemen in locating crosses between two circuits. Suppose No. 2 and No. 3 to be crossed. The first thing to be done is to test for a ground. If either of the circuits are grounded it must be found and cleared before the cross can be considered. If the circuit be free from grounds, one of the circuits in question is then grounded in the station, say No. 2 be the one; then with the magneto cell he starts out on No. 3 circuit. The process is similar to that described in finding an open circuit so far as the method of testing is concerned; the difference between the two lies in the fact that in the first case you are trying to find the reason you do not get a ring, and in the second case the reason you do get a ring. After proceeding to a lamp on No. 3 circuit, and taking the wires out of the binding posts of the lamp, one side of the magneto is grounded, by connecting a wire to a convenient water pipe or gas pipe, or, if the earth be moist, by driving a screw-driver into the ground and connecting to that; then with the other side of the bell, the lineman can connect the line wire and test toward the station. If he gets a ring, the point of contact between the two circuits, of course, lies between the station and the place of testing. This will be apparent if you bear in mind the fact that No. 2 circuit is grounded in the station, and when the ground is made on one side of the bell it is equivalent to connecting it to No. 2 circuit, and the only reason the connection is not made to the circuit direct is because it may be a mile or more distant.

Having dealt with the open circuit and short circuit, and a cross; now let me take up that root of trouble, the "ground." I will venture the assertion that nine-tenths of the outside trouble in central station work is either directly or indirectly traceable to grounds, and if there be any central station men present this evening, I believe they will bear me out in the statement.

Where the lineman is called upon to clear one cross, he has nine calls for grounds; and it is equally true regarding open circuits, although short circuits are frequently found to consist of two grounds. I will recite an instance of this a little further on. If I treat the subject of grounds a little more fully than the others, I do so for two reasons. First, because it is of more importance than any of the others, on account of the more frequent occurrence; second, because it offers an opportunity to use instruments in locating the trouble. The instrument I use is a voltmeter, reading from 0 to 3,000.

The magneto bell method of locating a ground is the same as the one described, that of opening the circuit and testing both ways. With the voltmeter, it is necessary of course to make the test while the circuit is running. I have found it a good practice to go over all the circuits at the switchboard with a ground wire while the lamps were burning. In this way I have frequently detected grounds on a circuit where other methods had pronounced them all right. If upon striking a circuit with a ground wire, you succeed in drawing out a flash about a yard long, and probably have to take two steps backward to break it, you will have a kind of foggy idea that there is a ground on that circuit, and if, upon examination, you find half your moustache and one eyebrow gone and it has taken about ten minutes to recover your eye-sight, then you feel pretty sure that you have found a ground circuit.

For the benefit of the uninitiated, I will say, that this singeing process will occur but once; for the next time the neophyte approaches a live circuit with a ground wire, it will be with a 10 foot pole, and the wire safely fastened at the proper end of it.

Having found a grounded circuit, the next thing to do is to find the ground on the circuit. If there be but one ground on the circuit, it will make no difference with the burning of the lights; but if there is one ground there is sure to be another sooner or later, and then the trouble begins. For this reason, and several others that might be mentioned, it is desirable to keep the lines clear of grounds at all times.

But returning to our problem of locating grounds, we will take the circuit from which comes the flash, for example call it No. 10, and in handling it, treat it with all the respect and deference due its importance. First, with the voltmeter take the electromotive force across the terminals on the switchboard; do not be satisfied with one reading, but take several at intervals of two or three minutes, for the voltage of an arc circuit is anything but constant. Suppose the average for several readings be 2,500 volts. By turning to your lamp list you may find that No. 10 circuit has 51 lamps of the so-called 2,000 candle-power. For convenience, we will assume the current to be 10 amperes; some systems use this current, others a little less. Again, suppose the circuit to be 10 miles long of No. 6 B. & S. wire. The resistance of one mile of this wire, as before stated, is 2·088 ohms; then 10 miles would equal 20·88 ohms. Now using Ohm's law of E equals R × C, we have 208·8 volts, giving us the electromotive force required to overcome the resistance of the line circuit. This 208·8 volts deducted from the total electromotive force of the circuit, 2,500 volts, leaves a remainder of 2,291·2, being the amount absorbed by the 51 lamps on the circuit. This would give an average of very nearly 45 volts per lamp; just about the proper voltage when burning a 4½ ohm arc. In the calculation with which we are dealing it is of course necessary to take into consideration the 208·8 volts lost in the line. If we divide this 208·8 by the number of lamps on the circuit it will give an average per lamp of a trifle over 4 volts; this added to the average lamp voltage will make a total of 49 volts; so that 49 is the constant to be used in our dealings with No. 10 circuit. We will now connect one side of our voltmeter to ground, and the other side to the positive side of the circuit. If we get a reading of 980 volts, for instance, and divide this by our constant of 49 volts it gives us 20, which means, of course, that the ground lies between the 20th and 21st lamp on the positive side of the circuit. If now we connect to the negative side and ground, and get a reading of 1,520 volts, by bringing our constant into use we divide 1,520 by 49 which equals 31—locating the ground between the 31st and 32nd lamp on the negative side of the circuit; precisely the same result as with the first test, and proving beyond a doubt the correctness of the first calculation. We are about to put our instruments away and resolve to have that ground cleared the first thing in the morning, when our dynamo tender informs us that the machine on No. 10 is running very light; he thinks there are some lights cut out on it, as he had just noticed it flash. Connecting our voltmeter between the ground and positive side as before, 980 volts is the result; just the same as we had left it a few minutes ago. Connecting now to the negative and ground, we find our reading to be 540 volts, instead of 1,520 as before. Dividing 540 by the constant 49, gives us 11, showing conclusively that another ground has appeared on the circuit between the eleventh and twelfth lamp on the negative side.

Now disconnecting the instrument from the ground and placing it across the terminals instead of a reading of 2,500 volts, we get but 1,520 volts. This divided by 49 equals 31 lamps left burning on the circuit; 31 from 51, the total number, leaves 20 lamps cut out by the grounds.

The number of lamps cut out could have been calculated without taking the terminal potential, by simply adding the two ground readings and deducting their sum from the terminal potential previously obtained, and dividing the result by the constant 49. All central stations have or should have maps of their circuits, showing on what streets they run, and the location of the lamps. If such maps be at hand we take out No. 10 circuit map, and counting 20 lamps from the station on the positive leg we locate one ground, and counting 11 lamps from the station of the negative leg, locate the other. Now when we call the lineman we do not simply tell him there are two grounds on No. 10, but we tell him to go to the corner of Twenty-first and B streets for one and Fifteenth and A streets for the other. If the maps above referred to are not to be had then you have to depend upon the lineman's knowledge of the lamps and circuits.

A short time ago I had a very peculiar case of ground to deal with; it had been raining and storming for several days, and circuits without grounds were held at a premium. One of our day circuits of 50 lamps was reported out; not a lamp on the circuit burning. A test showed the circuit to be grounded. Linemen were sent out on the circuit, but after tracing it from one end to the other, failed to find the trouble. The machine was kept on the circuit all the time, running at 10 amperes, on almost a dead short circuit. When the first lineman failed to find the trouble another was sent out with the same result. Things were becoming interesting. I took the voltage of the circuit and got a reading of 40 volts—about that—I don't quite remember the exact figures; between the positive side and ground, about 13 volts; between the negative side and ground, about 27 volts, showing, as had been reported, that every lamp on the circuit was out. By the method described in locating a short circuit on trunk lines, I determined the number of feet of wire from the station to the ground on the positive leg, that being the nearest one to the station, and with a lineman started out to find the cause of all the annoyance. I spaced the distance off with my eye as near as I could, and in 15 minutes from the time we left the station the 50 lights were shining forth in all their brilliancy, and the innocent telephone wire was credited with another knock out. The other ground was found a little later, where the voltmeter had located it.

ROTATION OF THE MAGNETIC FIELD.*

By CHAS. STEINMETZ.

A PART of space, where magnetic forces are acting, is called a *magnetic field of force*. The magnetic force at any point of the magnetic field is—analytically as well as physically—represented completely, in all its inductive and mechanical effects, by two quantities, the *intensity*, and the *direction* of the magnetic force. In Faraday's geometrical representation of the magnetic field the *density* of the *magnetic lines* corresponds to the *intensity*, the *direction* of the magnetic lines to the direction of magnetic force. Consequently, as long as the two characteristic quantities of the magnetic field, the *intensity* and the *direction* of the magnetic force, are *constant* in any point of space, the magnetic field must be said to be *stationary and constant* at this point of space, and any representation of the magnetic field which does not conform to this, has to be rejected as not giving a correct representation of the phenomenon. While on the other hand, if intensity or direction of magnetic force at any point of space vary in time, the magnetic field at this point is a variable function of time, which may be a periodical function, or not.

Now let us examine the case of a cylindrical, uniform magnet, revolving around its axis, either a permanent magnet, or a cylindrical iron core with a concentric magnetising helix, in the latter case both, or only the core, or the helix revolving.

* New York *Electrical Engineer*.

In any one of these cases, intensity and direction of magnetic force are constant functions of time, that is, stationary, at any point of space, and consequently the assumption of any rotation of the magnetic field is not warranted.

In the case of a horseshoe magnet revolving around one of its legs, the magnetic constants at any point in space are periodical functions of time, and at all points of a circle concentric to the axis of rotation. These functions are identical, but differ in phase progressively; but this does not involve the rotation of the magnetic field any more than the tides of the ocean—which are periodical functions of time, differing in phase in space—mean a rotation of the waters of the ocean around the earth.

NEW PATENTS—1893.

402. "An improved automatic cut-out for series incandescent electric lighting." A. P. DONNISON and M. H. BARBER. Dated January 9th.

442. "New electric lighting of gas engines." T. CARLO. Dated January 9th.

449. "Improvements in or relating to electric motors." I. E. STOREY. Dated January 9th. (Date applied for under Patents Act, 1883, Sec. 103, June 9th, 1892, being date of application in United States.)

457. "Improvements relating to the coating of wire and other rolled or drawn metallic sections by electro-deposition, and apparatus therefor." S. O. COWPER-COLES and THE METALLURGICAL COMPANY, LIMITED. Dated January 9th.

471. "Improvements in variable speed electric motors." C. A. ALLISON. (Communicated by C. Hering, United States.) Dated January 10th. (*Complete.*)

510. "Improvements in electric transmission of power." E. DE PASS. (Communicated by E. W. Rice, Jun., United States.) Dated January 10th. (*Complete.*)

511. "Improvements in coating aluminium and aluminium alloys." G. WEGNER and P. GUHRS. Dated January 10th. (*Complete.*)

512. "Improvements in soldering aluminium and alloys of aluminium." G. WEGNER and P. GUHRS. Dated January 10th. (*Complete.*)

516. "Improvements in measuring and recording instruments for electric currents." H. H. LAKE. (Communicated by E. Weston, United States.) Dated January 10th. (*Complete.*)

517. "Improvements in instruments for measuring electric currents." H. H. LAKE. (Communicated by E. Weston, United States.) Dated January 10th. (*Complete.*)

518. "Improvements in apparatus for measuring electric currents." H. H. LAKE. (Communicated by E. Weston, United States.) Dated January 10th. (*Complete.*)

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520. "Improvements in and relating to apparatus for measuring and indicating electric currents." H. H. LAKE. (Communicated by E. Weston, United States.) Dated January 10th. (*Complete.*)

538. "Electro-magnetically heated receptacles and articles." W. MITCHELL. Dated January 10th. (*Complete.*)

562. "Improvements in electric measuring instruments." W. T. GOOLDEN and S. EVERSHED. Dated January 10th.

583. "Improvements in self-recording electric apparatus." A. WRIGHT. Dated January 11th.

585. "System for suspending electrical conductors (without the use of poles) by means of wires." A. E. MUIRHEAD. Dated January 11th.

601. "Improvements in and relating to the manufacture of electric incandescent lamps." J. R. HUGHES. Dated January 11th.

605. "Improvements in and relating to the measuring of electricity, and in meters therefor." R. KENNEDY. Dated January 11th.

628. "Improvements in brackets, standards, and other electric light fittings." H. FARADAY. Dated January 11th.

660. "An improved method of manufacture of elements or plates for secondary batteries." H. F. KIRKPATRICK-PICARD and H. THAME. Dated January 11th.

694. "Air tight electric lighting wire casings." R. ATKINSON. Dated January 12th.

724. "Improvements in filaments for incandescent electric lamps." F. R. POPE. Dated January 12th. (*Complete.*)

736. "Improvements in the manufacture of white lead and other compounds electrolytically, and apparatus therefor." J. C. RICHARDSON. Dated January 12th.

757. "Improvements in platinised electrodes." H. T. BARNETT Dated January 13th.

758. "Improvements in connection with carbon electrodes." H. T. BARNETT. Dated January 13th.

775. "Improvements in electric arc lamps." E. CONRADY. Dated January 13th.

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813. "Improvements in or connected with the manufacture of electrodes for electric accumulators." C. POLLAK. Dated January 13th.

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ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1891.

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6,485. "Improvements in dynamo-electric and electro-dynamic machines." A. I. GRAVIER. Dated April 15th. The inventor employs a ring armature of the "Gramme" type, the diameter of which is relatively large compared with its transverse section. The ring is built up of a series of very thin iron discs or strips cemented together; each disc or strip being insulated from the adjoining discs or strips. The surface of the ring thus formed is covered with insulating material and wound with a single layer of copper wire, so as to form either a continuous or a divided circuit, as hereinafter explained. An ordinary commutator is used. The pole pieces of the electro-magnets can be placed anywhere in relation to the armature, according to the construction of the machine. The pole pieces are not expanded. 4 claims.

6,730. "Improvements in dynamo-electric machines." W. M. MORDEY. Dated April 18th. Has reference to dynamo-electric machines of the type in which an armature having an annular series of coils is arranged between two series of magnetic poles or polar extensions. The improvements relate to details of construction of such machines, and more particularly to the mode of supporting and arranging the armature coils, and to means for placing the rotating field magnet winding in connection with a source of electric energy. 10 claims.

8,323. "Improvements in thermo-electric apparatus." J. GOLDSMID. (Communicated from abroad by V. RIATTI, of Milan.) Dated May 14th. A vessel, preferably of rectangular form, made of material such as wood, which is a bad conductor of heat and electricity, and having on its bottom an electrical conductor such as a plate or a number of connected pieces of metal, is charged to a certain depth with a saline solution rendering it conductive of electricity, preferably solution of a salt of the metal which occupies the bottom of the vessel. The upper part of the liquid is heated by steam or hot gases passed through horizontal tubes which are just submerged in the liquid, or by directing jets of flame or heated gas on metal plates which are just submerged in it. A conducting plate or body may also be placed in contact with the upper part of the liquid. The tubes (when they are of conducting material) or the conducting body in the upper part of the liquid and the metal in the lower part of the liquid being connected in circuit by suitable conductors, when heat is applied at the upper part of the liquid, a current of electricity is transmitted through this circuit. 1 claim.

9,291. "Improvements in electric arc lamps." A. E. BISHOP. Dated June 2nd. Consists in providing a metal beam of an improved form in one piece with an oblong or other opening in the centre to allow of its being slid on an inverted tube, with enough play for it to turn on its centre through the requisite angle. Each end of the metal beam is forked to receive cores or plungers, and allows them to operate in the series and shunt solenoids. The metal beam is secured to the inverted tube and the cores or plungers to the ends of same by means of adjustable centres or pivots secured by lock nuts or their equivalents to prevent sticking and reduce friction to a minimum. The metal beam is furnished with mechanism for making and feeding the electric arc, and for rendering the safety cut-out of the lamp automatic. 5 claims.

9,628. "Improvements in or connected with negative elements (positive electrodes in charging secondary cells) of voltaic batteries." D. G. FITZ-GERALD. Dated June 6th. According to this invention a thin layer of gold or of platinum or of both is or are applied by electro-deposition or otherwise upon the whole or a portion of a strip, tang, contact piece, or washer of lead or lead alloy. The precious metal so deposited upon the lead or lead alloy allows of the passage of the electric current from the lead strip or the like to the lithanode without allowing the lead or lead alloy to be impaired or destroyed by oxidation during the process of charging, and without the production of a layer of lead-sulphate between the lead or lead alloy, and the lithanode in the operation of discharging the element. 1 claim.

9,629. "Improvements in or relating to the negative elements (positive electrodes in charging secondary cells) of voltaic batteries." D. G. FITZ-GERALD. Dated June 6th. Consists in coating the grid, or support, of lead, or lead alloy, with gold or with platinum, or with platinum superposed upon gold, which coating is preferably effected by means of electro-deposition. 1 claim.

9,734. "Improvements in dynamo-electric machines." W. ALDRED. Dated June 9th. Consists of two armatures mounted parallel on one shaft; the said armatures are wound with a continuous coil on each, and are connected together in the same manner as when connecting right and left-handed limbs of an horseshoe electro-magnet when they are to be respectively N. and S. The two armatures work in a uni-directional field, each armature being under the direct influence of one pole of magnetism only, or uni-polar. The outside connections are brought to two plain rings, which will be respectively negative and positive, thus forming a direct continuous current without the aid of commutation. 1 claim.

9,803. "An improvement in galvanic batteries." W. J. ENGLEDUE. Dated June 9th. The inventor provides the battery with a top or cover which can be clamped liquid-tight thereto by means of an India-rubber or other suitable elastic ring or jointing washer, so that the battery may be inverted without escape of the electrolytic fluid, and he fills the battery with the electrolytic fluid to such a height only as will cause a part, but not the whole, of the elements or electrodes to be immersed therein. After use of the battery in its normal position until the current has fallen below what is requisite for producing the desired efficient result, whether for producing an electric light in a miner's lamp or other purpose, the battery is inverted, and a larger portion of the elements or electrodes then becomes immersed, exposing a larger surface of such elements or electrodes to the action of the weakened electrolytic fluid, thereby restoring the current more or less nearly to what it was at first. By these means a more constant current can be produced than has been heretofore practicable without restoring the strength of the electrolytic fluid as it becomes weaker. 4 claims.

10,082. "An improvement in voltaic batteries." P. JABLOCHKOFF. Dated June 13th. The inventor employs, as the one electrode of a cell, a vessel, cylindrical or rectangular, made of carbon more or less porous, closed at the bottom, open at the top, and filled up with fragments of coke, or, preferably, of peat charcoal. Having filled it he closes it by a porous lid, which may be of peat. Around the lower part of this vessel, at some distance from its sides, he places, for the other electrode, several thicknesses of zinc or iron plate, extending about one-third of the height of the carbon vessel. He encloses the whole in a basket or bag, having a thick lining of spongy material such as peat, and places it in a jar of non-conducting material. He charges this jar and, consequently, the lower portion of the spongy lining and the space between the metal and the inner carbon vessel, with solution of nitrate of soda or of potash, and he pours into the carbon vessel nitric acid, so much diluted that it does not fume. 2 claims.

10,090. "An improved process for the electrolytic production of aluminium." L. GRABAU. Dated June 13th. Cryolite is fused in a receptacle through the agency of the electric current, and into this fluid bath is introduced during the electrolysis a mixture of aluminium, fluoride and soda (which may be taken as an example) in definite proportions according to the quantity of aluminium which is separated. 1 claim.

10,256. "Improved means for operating electric bells for signalling and other purposes." F. KING AND W. P. MENDHAM. Dated June 17th. The object of the invention is to afford means for giving signals by electric bells. This is accomplished by using a set of tuned bells which are struck by hammers actuated by the electric current. The inventors employ an automatic contact-maker, by turning the handle of which the current is transmitted to the bells. A drum is rotated by the handle, upon which drum are pins which touch in turn contacts in a certain order, and cause the bells to sound accordingly. 2 claims.

16,270. "Improvements in or appertaining to accumulators for the storage of electric currents." W. P. THOMPSON. (A communication from abroad by E. Correns, of Berlin.) Dated September 24th. Consists in mixing with the substances employed for the storage of the current the silicate of a metallic earth in order to cause the whole to harden to a stone-hard mass.

17,655. "Improvements relating to the heating of metals by electricity, and to machines therefor." G. D. BURTON, A. H. EDDY, and G. T. BRIGGS. Dated October 15th. Consists in certain new and useful constructions and combinations of the several parts of the same, and a method of operating and using the same, whereby the inventors are enabled to speedily and economically bring long and large bars of metal to a heat suitable to work or fashion them into the ultimate form desired. 16 claims.

20,864. "A new or improved combined electro-medical apparatus, coil, and battery." T. C. HODGKINSON and H. T. TOMPSITT. Dated November 30th. The object of the invention is to effect improvements in the design and construction of electrical instruments used in surgical, medical, and other applications of electricity to the human body or the bodies of the lower animals, and that such instruments shall be complete and capable of adjustment, and within a portable compass. 6 claims.

21,551. "Improvements in apparatus for the projection of electric or other light." S. PITT. (A communication from abroad by Messrs. Sautter, Harlé and Company, of Paris.) Dated December 9th. This invention aims at obtaining the continuous zone by means

of a divergent aplanetic reflector, having great horizontal divergence, whilst preserving to the beam a luminous intensity independent of the divergence. 2 claims.

1892.

14,912. "Auxiliary mouth-piece for telephones." W. N. MARCUS. (Under International Convention.) Dated February 10th. Consists of a bent tube, to one end of which is fixed a trumpet mouth-piece, the other end being fitted in a friction socket, and by which socket the tube is attached to the transmitter box of the telephone by clamp springs. 2 claims.

CORRESPONDENCE.

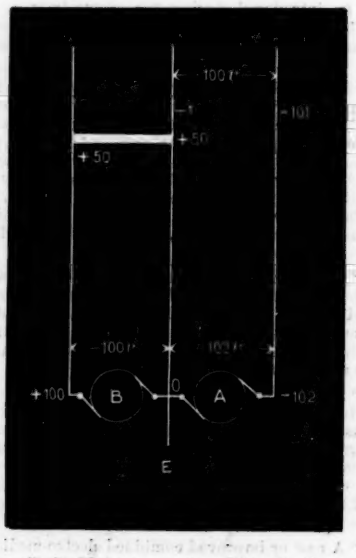
Effect of a Short-circuit on the Three-Wire System.

In the recently-tried three-wire case, the question was raised as to the effect of short-circuiting an outer and the neutral wire, and I am surprised to see that a difference of opinion exists as to what would occur should such a short-circuit be formed.

Mr. Andrews, according to your report, said in reference to the "bradawl" evidence concerning Sauchiehall Street, "If the lamps increased in brightness, that would show that it was not the three-wire system." Mr. Rankin Kennedy, commenting on the same evidence as to lamps on the short-circuited side being extinguished and on the other side brightened, opined "that that could never have happened on the three-wire system." Mr. Swinburne, however, "thought that it was quite possible that with an old machine of the type used then, short-circuiting one side might increase the electromotive force on the other."

So far as your condensed report states, this question was not gone into further than as a mere matter of opinion. A little consideration seems to show that, with three wires of equal thickness, the brightening effect on the lamps in the second side would be very great, and with a thin neutral wire, still greater.

In the diagram, let A and B be two dynamos supplying a three-wire system; and, for the sake of simplicity, suppose the armature of each to have a resistance equal to two per



cent. of that of the two outside mains in series, and to give an E.M.F. on open circuit of 102 volts. Also let the neutral wire be of the same size as the outside ones.

First, consider dynamo A working alone and delivering a small current with a loss of 2 volts in the mains (the drop in the armature will not be worth taking into account). The E.M.F. at the lamp terminals will then be 100 volts.

Next suppose dynamo B working alone with the mains short-circuited at the distant end. As long as the circuit lasts intact, the whole energy must be spent therein in the proportion of 100 watts in the mains to 2 in the armature, series field-coils counting as part of the mains.

Supposing the dynamo in each case to generate a constant E.M.F. (in itself, not at the terminals) and the neutral wire to be earthed at the dynamo end, the potentials in reference to earth at different parts of the system will be as shown in the diagram; the P.D. between the neutral wire and the A main being 151 volts. If the neutral wire is thinner than the outside ones, the potential at its distant end will be still greater than shown; and, of course, a smaller current will be flowing through the increased resistance.

Running the two dynamos together will slightly modify the figures on the diagram, owing to the small current from A having to pass through the B circuit; but it is evident that the pressure on the lamps in the second side will be increased by the short-circuit on the other side by an amount reaching or exceeding 50 per cent., enough to cause a violent increase in the brilliancy of the light.

The action described is only what takes place in a less degree when (using over-compounded dynamos) the two sides are unequally loaded, and is the occasion for the use of regulators or equalisers.

W. S. Boult.

January 23rd, 1893.

Starting of Multiphase Motors.

Although I convinced myself at the Frankfort Exhibition and elsewhere, of the fact that multiphase motors start with their normal load, to make assurance doubly sure I communicated with the Electrical Company, Limited, who in their turn obtained a reply from Berlin, stating that both types of multiphase motors, viz., those with and those without contact rings start with the full load on. By "full load," of course is meant the object to be driven by the motors at its normal speed when once in motion, and this includes "pumps, hauling and winding machines, and coal cutters," as mentioned by Mr. Ernest Scott in his letter appearing in your issue of January 13th. These multiphase motors being non-synchronous, the loads can be applied and thrown off suddenly, and they may even be momentarily overloaded to the extent of 50 per cent., whilst in motion, without damaging anything. I can assure Mr. Scott that for the distribution of power in mines, the multiphase motor would answer admirably.

A. Reckenzaun.

January 23rd, 1893.

Patent Litigation and Consulting Engineers.

The remarks in your issue of January 20th on patent litigation are founded on a misapprehension. You state that, when consulting engineers are advising companies or corporations, they ought to warn their clients as to the existence of patent rights, so that the latter may not be sued for infringement after many years' use of the patent. You specially cite the case of Dr. Hopkinson's three-wire patent, in which the St. James's and Pall Mall Company have been declared infringers. I beg to state that, when I advised the directors that the three-wire system must be used, I strongly insisted upon the necessity of making arrangements with the patentee. Some of the directors thought that the claim might be evaded, but I did not agree, and upon them alone lies the responsibility of the late judgment.

With regard to your remarks as to the position which ought to be taken up by a consulting engineer I entirely agree, and believe there is a larger number of the class who adopt those views than you seem to imagine. I would even go farther than you do, and say that no consulting engineer ought to have any pecuniary interest in, or be permanently retained by, any firm of manufacturers or contractors.

George Forbes.

January 24th, 1893.